PROJECT MANUAL

CONCORD CARLISLE HIGH SCHOOL
CONCORD, MA

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DESIGN DEVELOPMENT SUBMISSION

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By Construction Manager

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* Trade Bid Required

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SECTION 210000

FIRE PROTECTION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Refer to Section 012300, ALTERNATES, for alternates which may affect the work of this Section.

C. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch through the Longmeadow Fire Department where work is being performed and until it is completed.

1.2 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, services and accessories necessary to Design, Furnish and Install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein. The Design shall conform to the documents and shall be subject to approval by the Architect.

B. Without limiting the generality thereof, the work to be performed under this Section includes:

1. Fire Service to 10’ outside building and/or as shown on the drawings.
2. A hydraulically designed combination automatic sprinkler system to provide 100% protection for the new and existing building as noted on the Drawings. Refer to Fire Protection Criteria on the Drawings. Prepare Working Drawings for approval of the Architect, the local authority having jurisdiction, and the owner's insurance company under stamp of an independent Registered Massachusetts Professional Fire Protection Engineer.
3. Backflow Control Device
4. Fire Department Connections.
5. Pipe and Fittings
6. Valves
7. Hangers
8. Sprinkler Heads
9. Furnishing and installation of Supervisory Switches and Controls
10. Systems Identification
11. Flushing and Testing of the interior system as provided herein. Coordinate, witness, and certify the flushing and testing of the exterior system and submit certificates. The exterior installation is provided in Division 33.
12. Drilling, Coring, Cutting & Patching of holes and openings (where the largest dimension thereof does not exceed 12 inches), for Fire Protection Piping and Equipment. All such holes require sleeves.

13. Scaffolding, Rigging, and Staging required for all Fire Protection Work. Comply with Division 01 requirements.
14. Provide Seismic Restraints for all Fire Protection Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference as work of the Fire Protection Sub Contractor. Seismic Restraints are required in both new and existing building.
15. Furnishing of Access Panels
18. Smoke and Firestopping Seals and sealing of all wall penetrations as detailed on the drawings. Refer to Section 078400 which defines the firestopping materials and methods.

1.3 RELATED WORK

A. The following items of work related to the Fire Protection Work are included under other Sections of the Specifications:

1. Fire Service up to 10 feet outside foundation wall: DIVISION 33 – SITE UTILITES
2. Cutting & Patching beyond 1.02, C.12 above: SECTION 010450 - CUTTING AND PATCHING.
3. Installation of Access Panels: Respective finish section.
4. Excavation and Backfill: DIVISION 31
5. Finish Painting: SECTION 099000: PAINTING
6. Wiring for Supervisory Switches, Electrical Alarm, and Flow Switches, and Power Wiring: SECTION 260000 - ELECTRICAL
7. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
8. Installation of Hood Suppression System – SECTION 114000 FOOD SERVICE EQUIPMENT

1.4 CODES, ORDINANCES, AND PERMITS

A. Perform all work in accordance with the following Codes:

1. 780 CMR: The State Building Code.
2. 527 CMR: The Fire Prevention Regulations.
3. NFPA-13-2007, NFPA-14-2007, and Owner's insurance company requirements.
4. All applicable Local, State, and Federal Codes, Statutes, or Regulations.
5. Town of Concord Fire Department.
6. Town of Concord Building Department.

B. Obtain all permits, approvals, etc., from the governing authorities and pay all fees and include cost in the bid, including approvals for the cross connection control device. Provide the Owner with the cross connection permit for the device in the Owner's name.

C. Refer to DIVISION 01 – GENERAL REQUIREMENTS for information regarding municipal permit and inspection fees.

1.5 RECORD DRAWINGS

A. Maintain on the Site two (2) sets of the approved Working Drawings, black or blue line on white, bearing original signatures or approval stamps of the various authorities having jurisdiction. On one (1) of these sets, clearly and neatly indicate in colored pencil, the actual location of all piping, sprinklers, and other equipment as it is being installed. Mains, sub-mains, control valves, etc., shall be dimensioned. These Drawings shall be available to the Architect/Engineer's field representative at all times.

B. Upon completion of the work and prior to final payment, transfer the above information onto reproducible copies (mylars) of the plans of the system, showing sizing, arrangement, and locations of all heads, piping, fittings, drains, test connections, flushing connections, valves, and valve lists. Refer to 780 CMR 9.0 for additional requirements.

1.6 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide operating instructions to the owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals in three-ring, loose-leaf binders, containing the following:

1. Complete Shop Drawings of all equipment.
2. Operation description of all systems.
3. Names, addresses, and telephone numbers of all suppliers of the system.
4. Preventive maintenance instructions for all systems.
5. Spare parts list of all system components.

1.7 SHOP DRAWINGS AND MATERIAL SCHEDULES

A. Refer to DIVISION 01 – GENERAL REQUIREMENTS for substitution of equipment and submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Fire Protection Subcontractor.

B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Subcontractor. The Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.

C. Submit Shop Drawings for the following materials and equipment.

1. Coordinated Working Drawings and hydraulic calculations including size, type, length, temperature rating of sprinkler heads, piping and the like. Indicate flow test results, design criteria, hydraulic reference points, diffuser and light locations.
2. Access Panels and Covers
3. Sprinkler Heads
4. Hangers and Seismic Restraints
5. Pipe, Fittings, and Appurtenances
6. Systems Identification
7. Valves
8. Fire Department Connection
9. Cross Connection Devices

1.8 COORDINATION DRAWINGS

A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.

B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.

C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 – GENERAL REQUIREMENTS of these Contract Documents.

1.9 GUARANTEE

A. Guarantee all work under this Section free from defects in workmanship or materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract.

B. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

1.10 DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make a complete working system ready for use.

B. The Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.

C. Refer to the Architectural, Structural, and Other Mechanical and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.

1.11 SYSTEM DESCRIPTION

A. Building is to be 100% sprinklered including all closets regardless of size.

C. Refer to Fire Protection Criteria on the Drawings. Conform to the zoning shown on the plans.

D. Locations of sprinkler heads are shown in some of the areas to be sprinklered only to establish the patterns and design intent. Major equipment and runs of piping may also be shown. Refer to reflected ceiling plan for location of all sprinkler heads. All sprinkler heads are to be installed dead center of tile.

E. The documents require that the building be covered 100%. This includes all closets, combustible concealed spaces, and other areas as required under NFPA-13-2007. These areas are to be included in the Sub-contractor's bid whether or not the heads are shown on the sprinkler plans.

1.12 ALARM FACILITIES

A. Furnish and install all Supervisory Switches, Flow Switches, Pressure Switches, and other Alarm Devices. Install all such devices on the piping and coordinate with the Electrical Subcontractor who shall wire all such devices to the Fire Alarm System. Every shutoff valve installed on this project shall have a supervisory trouble switch wired to the Fire Alarm Panel.

1.13 PIPE MARKER IDENTIFICATION SYSTEM

A. Mark all fire mains installed under this Section with a marking system in basic colors conforming to those specified in A.S.A. A-13. Markings shall indicate pipe content and direction of flow. Apply markers every 20' on center on piping which is exposed in mechanical or storage areas and above suspended accessible ceilings. Also, apply at all access panels, valves, tee joints, alarms, and/or controls.

B. Adhesive system may be used throughout except at the mechanical rooms in which case markings shall be painted on.

1.14 VALVE TAGS

A. All valves installed in the Fire Protection Contract shall be tagged. Tags shall be secured to valves with chain link and shall be marked with 3/4" high letters as to function. All valve tags shall indicate the Fire Zone.

1.15 IDENTIFICATION SIGNS

A. All equipment and systems shall be identified with signs furnished and attached in accordance with NFPA 13.

1.16 BREAKDOWN

A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.

B. No requisition will be approved until the breakdown is delivered to the Architect.

1.17 VISIT TO SITE

A. Prior to submitting a bid, visit the site of work and become familiar with existing conditions at the site of the work. Any assumptions made are at this Subcontractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment furnished under this Section shall be new, unused, first quality of a manufacturer of established reputation and shall be U.L./F.M. approved. Each valve, fitting, section of pipe, piece of equipment, etc., shall have cast or indelibly stamped thereon the manufacturer's name, pressure rating where applicable, type, etc. All threads for fire department connection shall conform to the standards of the Local Fire Department.

2.2 PIPE AND FITTINGS

A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. Standards. All grooved products shall be of one manufacturer to conform to NFPA Standards.

B. All piping installed under this Section shall be in accordance with the following:

Service	Materials
Trim piping around alarm valves, sprinkler piping 1-1/2" and smaller	ASTM A-53, Schedule 40 steel pipe, black for wet system, galvanized for dry
Sprinkler and standpipe piping 2" and greater	Schedule 10, ASTM A-135 U.L./F.M. steel by Allied, or equal, black for wet system, galvanized for dry
Underground service	CL 52 ductile iron pipe

C. Fittings on fire line piping, 2" and larger, shall be Victaulic Fire Lock Ductile Iron Fittings conforming to ASTM A-536 with integral grooved shoulder and back stop lugs and grooved ends for use with Style 009-EZ or Style 005 couplings.

D. Fittings for standpipes and risers, 2-1/2” and larger, and where ever required to conform to Seismic Requirements shall be Victaulic Vic-Flex Style 75 or 77 with Fire Lock Gasket.

E. Branch line fittings shall be welded or shall be Victaulic 920/920N Mechanical Tees.

F. Schedule 10 pipe shall be roll grooved. Schedule 40 pipe where used with mechanical couplings shall be rolled groove and shall be threaded where used with screwed fittings.

G. Fittings for threaded piping shall be malleable iron screwed sprinkler fittings.

H. All pipe and fittings shall be U.L./F.M. approved for sprinkler and standpipe service. All pipe and fittings shall be galvanized for dry or pre-action system and black for wet system.

I. Fittings on underground fire service piping shall be 250 psi gray iron fittings with mechanical joint ends. Coordinate with site contractor to assure all joints are properly thrust blocked.

2.3 JOINTS

A. Threaded pipe joints shall have an approved thread compound applied on male threads only. Teflon tape shall be used for threads on sprinkler heads.

B. Joints on piping, 2" and larger, shall be made up with Victaulic, or equal, Fire Lock Style 005, rigid coupling of ductile iron and pressure responsive gasket system for wet or dry sprinkler system as recommended by manufacturer. Couplings on dry systems shall be galvanized. Cutting, roll grooving, lubrication, and assembly of all joints shall be made strictly in accordance with manufacturer's recommendations. Exercise particular caution in the use of lubricant to avoid “squeeze out” of lubricant when system is in service.

C. All joints on Fire Service under slab shall be restrained up to the service stub flange connection above slab.

2.4 VALVES

A. All shutoff and control valves shall be U.L./F.M. approved, indicating type valves equipped with a supervised trouble switch wired to the fire alarm system. Shutoffs and zone valves may be either OS&Y indicating gates or butterfly valves.

B. Gate valves shall be outside screw and yoke indicating type, 175 psi W.P. and U.L./F.M. listed, Jenkins or equal. All such valves shall have supervised trouble switch.

C. Butterfly valves shall be Victaulic Series 705-W for 2-1/2” and larger, and Milwaukee indicating type U.L./F.M. butterball for threaded service. Coordinate with Electrical Sub-contractor to have factory installed monitor switches compatible with the remainder of the Fire Alarm System.

D. Check valves shall be iron body bronze mounted U.L./F.M., 175# W.P. or U.L./F.M. wafer checks. Grooved end valves shall be Victaulic Style 717 Fire Lock Check Valve.

E. Ball drips shall be Potter Roemer #5682, 3/4" straight design ball drip valve.

F. Drains shall be provided in the systems as may be required by field conditions. Provide drains at all low points and wherever necessary to insure that all portions of the sprinkler piping may be completely drained. Test connections shall be provided as required to test all portions of the system. Pipe low point drains and test connections to suitable receptor as determined in field or shown on Drawings.

G. Install an inspector's test connection at the furthest point of each sprinkler zone. Run discharge back to a suitable receptor. Exterior wall penetration is permitted with test drain but only as approved by the Architect.

2.5 SPRINKLERS

A. All sprinklers to be used on this project shall be Quick Response type and shall be stamped with date of manufacture and temperature rating. Temperature ratings shall be determined by the location of the heads and shall be 155 degrees F. throughout except in special areas around heat producing equipment in which case use temperature rating to conform with hazard as specified in NFPA 13-2007. Orifice diameter and K factor shall be appropriate to meet the hydraulic design criteria, the available water supply, and NFPA Standards.

B. Furnish spare heads of each type installed located in a cabinet along with special sprinkler wrenches. The number of spares, location of cabinet, etc., shall be in complete accord with NFPA 13-2007.

C. Upright sprinkler heads in areas with no ceilings shall be Tyco Model "TY-FRB" Quick Response, upright natural bronze finish heads. Include heavy duty sprinkler guards in all mechanical and storage rooms, gymnasium outdoor activity, aerobics, wrestling, auto shops and general shop.

D. Sidewall heads shall be Tyco Model "TY-FRB" Quick Response with white polyester head and escutcheon.

E. Pendent wet sprinkler heads shall be Tyco Model "TY-FRB" Quick Response recessed adjustable escutcheon, white polyester finish.

F. Pendent dry sprinkler heads shall be Tyco Model "DS-1" Quick Response dry type, white polyester finish and escutcheon.

G. Dry sidewall heads shall be Tyco Model "DS-1" dry horizontal sidewall heads, white polyester finish.

H. At Contractor's option provide Aqua-Flex series AQB braided system complete with all accessories or approved equal stainless steel sprinkler fitting at sprinkler heads. Installation is to be as per manufacturer requirements. Hydraulic calculations are to indicate flexible connections if used.

2.6 FIRE DEPARTMENT CONNECTION

A. Fire Department Inlet Connection shall be Croker #6360 Series; 4" Storz inlet x 4" outlet, 30 degree elbow, brass plate, and stamped "Sprinkler-Standpipe". Install 1/2" ball drip valve and chrome plated trim wall fitting on bottom of inlet fitting body. Provide access panel for servicing the ball drip.

2.7 FIRE STANDPIPE EQUIPMENT

A. Fire Department Valves shall be Croker Series 5015 Fire Department Valves fitted with 2 ½" national standard x 1 ½" iron pipe reducer, caps and chains all conforming to Local Fire Department thread standard. Valves shall be polished chrome plated and shall be mounted in a recessed cabinet as indicated on Drawings.

B. Cabinets for the Fire Department Valves shall be Croker #2700 - Modified 18" x 18" x modified 10" deep. cabinet, fully recessed, solid door, prime painted steel. Include graphic and door catch.

C. Provide 24" x 24" access panels at floor control locations or recessed cabinets as appropriate to the wall construction. Provide graphic.

D. Fire Hose Cabinets located in the stage area shall be Croker Series 2100 full recessed mounted, prime painted steel door with graphic equipped with 2½" valve with 1½" fire hose rack containing 50 feet of 1½" Pr. Superflex hose and nozzle conforming to local fire department standards.

2.8 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

A. Furnish and install All Supplementary Steel, Channels, and Supports required for the proper installation, mounting, and support of all equipment.

B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.

C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Fire Protection Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.

D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90 degree fittings, as required to suit the construction and installation conditions.

2.9 HANGERS AND SEISMIC RESTRAINTS

A. Hangers shall be furnished, installed, and supported from the building structure in accordance with NFPA - 13, Section 230548 and Drawing VS-1.

B. All piping whether in new or existing building shall be seismic restrained.

2.10 ALARM DEVICES

A. Flow switches shall be vane type water flow detectors with 0-70 Sec. Adjustable non-accumulative retard device and (2) single pole double throw contacts, Notifier Series WFD Potter, VSR.F or equal.

B. Pressure switches shall be adjustable Potter Model PS10A or equal.

B. High/Low pressure switches shall be adjustable Potter Model PS40A or equal.

C. Supervisory switches on all O.S. & Y. gate valves shall be Notifier NGV complete with mounting bracket.

D. The wet system alarm device shall be Reliable or equal Model ‘E’ alarm valve with “E1” trimmings package to include Model ‘C’ water motor alarm and electric sprinkler alarm switch.

E. Refer to Drawings for additional devices. Co-ordinate, prior to ordering devices, with the Electrical Sub-Contractor to assure device compatibility with the Fire Alarm System.

2.11 DOUBLE CHECK VALVE ASSEMBLY

A. Double check valve assembly shall be State approved, U.L./F.M. approved, with iron body bronze mounted construction complete with supervised OS & Y gate valves and test cocks. Furnish two (2) spare sets of gaskets and repair kits.

B. Double check valve assembly shall be of one of the following:

1. Watts Series 757-OSY
2. Wilkins 350A-OSY

3. Conbraco Series 4S-100

C. In the name of the owner pay for, file for, and obtain required permits from D.E.P. and/or local authority whichever has jurisdiction prior to installation.

2.12 ACCESS DOORS

A. Furnish Access Doors for access to all concealed control valves, drains, inspector's tests, supervisory devices, and to all other concealed parts of the system that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate Section of the Specifications for the surface upon which the panels are mounted.

B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12" x 16"). When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

C. Access Doors shall be prime painted and be complete with cylinder lock and two (2) keys as manufactured by Acudor, Inland Steel Products Company "Milcor", or Walsh-Hannon-Gladwin, Inc., "Way Loctor". Type shall be as follows:

Acoustical Tile Ceiling	Acudor AT-5020
G.W.B. Surfaces	Acudor DW-5040
Masonry Construction	Acudor UF-5000
Fire Rated Construction	Acudor FB-5060

D. Access Doors Shop Drawings shall be submitted to the Architect for approval.

2.13 TEST HEADER

A. Furnish and install a Croker model 6818-PC test header where indicated on the drawings.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION METHODS

A. All work shall be installed in a first-class manner consistent with the best current trade practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.

B. Protect all concealed heads. Coordinate and advise finishing trades so as to prevent painting of sprinkler heads or inadvertent filling with paint or jointing compound of required air spaces in the case of the concealed type sprinkler heads.

3.2 WORK COORDINATION AND JOB OPERATIONS

A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.

B. Before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.

C. Coordination Drawings are for the Contractor's and the Architect's use during construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.

D. Detailed procedures for coordination Drawings are contained in DIVISION 01 – GENERAL REQUIREMENTS of these Contract Documents.

E. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.

F. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Fire Protection installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.

G. In case of failure to give proper information as indicated above, sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.

H. Obtain from the other trades, all information relative to the Fire Protection Work to be executed in conjunction with the installation of their respective equipment.

3.3 CUTTING AND CORE DRILLING

A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings.

B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.

C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified.

D. Patch all holes up to the sizes indicated in Section with material and methods as are specified in the Section of the Specifications for the finish trade involved. Holes which are improperly done due to poor materials or method, shall be patched to the satisfaction of the Architect by the finish trade and back-charged to this Subcontractor.

3.4 CLEANING AND PROTECTION

A. Protect all materials and equipment during shipment and installation and properly handle and store at the job site so as to prevent damage. Assume full responsibility for protection of work until its completion and final acceptance.

B. Keep the premises reasonable clean at all times and remove rubbish caused by the Fire Protection work as directed by the Architect.

C. Upon completion of this work, clean all sprinklers, and equipment and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work by others.

3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

A. All piping passing through slabs, floors, walls, and partitions shall be sleeved and all such sleeves shall be furnished and installed by the Fire Protection Subcontractor as detailed on the Drawings and herein specified. Fire Protection Contractor, shall do his core drilling as approved by the Architect and the cored opening shall have a sleeve caulked and leaded in place. Set sleeves in concrete floors and walls as soon as forms set and before concrete is poured.

B. All pipes passing through floor, whether slab-on grade or above grade levels shall be sleeved with sleeve extending 1" above floor. This includes all piping in toilet room pipe space, stairwells, closets, partitions, etc. In mechanical penthouses, pipe sleeves shall extend 4" above floor.

C. All sleeves shall be Schedule 40 galvanized steel pipe and shall be reamed. There shall be 1/2" annular space between the sleeve and pipe. Sleeves on drywall, masonry, or concrete walls and partitions shall be flush with wall on both sides.

D. The space between sleeve and pipe, in all cases, shall be filled with U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.

E. Inserts, where required, shall be furnished and set by the Fire Protection Subcontractor and, where necessary, may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1" into concrete.

F. Escutcheons: All exposed pipe, uncovered, passing through walls, or floors, or ceilings, shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.

3.6 TESTING

A. Flush the system and test all work in the presence of the Architect and/or Engineer and as required by NFPA and the Insurance Company. The flushing and testing procedures to be followed are specified herein. At the completion of the testing, submit fully executed copies of Contractor's Material and Test Certificate for both above ground and underground piping as contained in NFPA-13.

1. Water Supply:

a. Flushing: Underground/exterior service entrance shall be flushed at a minimum velocity of 10 fps in accordance with NFPA Standards 13, 14, and 24. The Fire Protection sub-contractor shall coordinate with Division 33 and shall notify the Water and Fire Departments prior to testing of the entire exterior system.

2. Sprinkler System:

   a. Hydrostatic Testing: The interior system shall be hydrostatically tested at 200 psi for 2 hours in accordance with NFPA 13 paragraph 24.2.1.
   b. Operational Testing: Water flow switches and associated alarm systems shall be tested by water flow through the inspectors test assemblies in accordance with NFPA 13, 24.2.3.
   c. Main Drain Test: A flow test shall be performed on the main drain valve and recorded on the Contractor's test certificate in conformance with NFPA 13, 24.2.3.4.
   d. Backflow Preventor Flow Test: The double check valve assembly shall be flow tested in conformance with NFPA 13, 24.2.5.

3. Standpipe or Bulk Fire Main:

   a. Flushing: The fire department connection piping shall be flushed at a minimum velocity of 10 fps in conformance with NFPA 13, and NFPA 14.
   b. Hydrostatic Testing: All piping shall be pressure tested at 200 psi for 2 hours in conformance with NFPA 14.
   c. Flow Tests: The system shall be flow tested at the hydraulically most remote hose connection in conformance with NFPA 14.
   d. Valve and Supervisory Switch Test: All valves and tamper switches will be tested by opening and closing valves in conformance with NFPA 14.

END OF SECTION

SECTION 21 08 00
COMMISSIONING OF FIRE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process to the fire suppression systems, assemblies, and components.

B. Related Sections include the following:
1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
2. Division 21 Fire Suppression
3. Division 28 Electronic Safety and Security for fire alarm interaction and requirements

1.03 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Wet sprinkler piping and equipment
   2. Fire pump
   3. Jockey pump
   4. Storage Tanks / Vault
   5. Dry system

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.02 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed, functional, and documented.
   2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided).
   3. All contractor-performed start-up procedures and tests are complete and documented.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.03 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Wet sprinkler systems
   2. Dry Sprinkler systems
   3. Fire pump systems
   4. Fire alarm system interactions

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 28 Electronic Safety and Security

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.04 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.02 SUMMARY above for the sections) for review.

3.05 SAMPLE FORMS

SAMPLE
Installation Checklist
Sprinkler Piping- Second Floor

Schedule ID# from drawings: Fire Protection
Reference Specification: 15300
Reference Drawing: F-101
Location: Second Floor

Model Verification

	Specified	Submitted	Installed
Manufacturer			
Model Number			
Pumps: QTY/HP			
Capacity			
Voltage/Ph			

Installation Checks

ID	Description	Pass/Fail	Comments
1	Verify sprinkler piping is run level.	☐☐	
2	Verify sprinkler piping is schedule 40 black steel piping and has been provided with the appropriate fittings: a) Piping 1" to 2" Threaded Fittings b) Piping 2-1/2" and greater- Victaulic Fittings	☐☐ ☐☐ ☐☐	
3	Verify piping has been properly supported.	☐☐	
4	Verify that the "Wet" system piping is not run in main telephone, electric, and data rooms.	☐☐	
5	Verify that standpipe and hose valve cabinets are installed at each stair landing at 48" A.F.F.	☐☐	
6	Verify that floor zone control valve assembly and drain piping has been installed.	☐☐	
7	Verify piping has been provided with seismic bracing where required.	☐☐	
8	Verify that auxiliary drains have been provided for all trapped piping.	☐☐	
9	Verify piping has been clearly identified with the proper color coding.	☐☐	

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

SAMPLE

Functional Performance Test
Fire Pump

1. Participants

Name/Representing		Participation (Testing, Witness, etc)
/		
/		
/		

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

(Y/N) An as-built version of the controls submittal has been provided.

(Y/N) A start up service report has been provided by a factory-authorized service representative.

(Y/N) The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: _ _. Date: _ _.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _ _. Date: _ _.

(Y/N) Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc. that were changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Fire Pump Status		☐
Fire Pump Inlet Valve Status		☐
Fire Pump Discharge Valve #1 Status		☐
Fire Pump Discharge Valve #2 Status		☐
Fire Pump Bypass Line Valve #1 Status		☐
Fire Pump Bypass Line Valve #2 Status		☐

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Jockey Pump Status		☐
Jockey Pump Inlet Side Valve Status		☐
Wet Alarm Check Valve Status		☐
Fire Pump Test Header Valve Status		☐
Fire Dept Connection Valve Status		☐
Low Pressure Alarm		☐

3. Sensor Calibration Checks. The sensors listed below are to be checked for calibration and adequate location.

Sensor	Location OK[1]	BAS Value	Measured Value	Pass Y/N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N

Sensor	Location OK[1]	BAS Value	Measured Value	Pass Y/N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N
	Y / N			Y / N

[1] *Sensor location is appropriate and away from causes of erratic operation.*
Comments:

4. Device Calibration Checks. The actuators or devices listed below are to be checked for proper operation and/or calibration.

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
Fire Pump Inlet Valve Status	1. On			Y / N
	2. Off			Y / N
Fire Pump Discharge Valve #1 Tamper Switch Status	1. Alarm			Y / N
	2. Normal			Y / N
Fire Pump Discharge Valve #2 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Bypass Line Valve #1 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Bypass Line Valve #2 Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Jockey Pump Inlet Side Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Pump Test Header Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N
Fire Dept Connection Valve Tamper Switch Status	1. Open			Y / N
	2. Closed			Y / N

5. Notes

6. Functional Testing Record

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1	JOCKEY PUMP AUTOMATIC START	1. With jockey pump in "AUTO" position lower sprinkler pressure by opening system drain valve. 2. Close system drain valve	1. The jockey pump will start when the system pressure reaches the pre-set turn on setting 2. The pump runs until the system pressure reaches the shut off setting at which time the jockey pump will stop.	Y / N	
2	FIRE PUMP AUTOMATIC START	1. With the jockey pump in the "ON" position, open the "Alarm Test Module" valve to reduce system pressure. 2. Close the "Alarm Test Module" valve.	1. The Fire Pump will start when the system pressure reaches the pre-set fire pump "start" setting 2. The system returns to the proper pressure. The fire pump runs for a predetermined time and shuts off at the end of that time period.	Y / N	
3	FIRE PUMP RUNNING ON EMERGENCY GENERATOR	1. If equipped, activate the Emergency Generator "RUN" switch. 2. With the emergency generator running and the jockey pump switch in the "OFF" position reduce the pressure in the sprinkler system by opening the Alarm Test Module valve 3. Close test valve 4. Return generator switch to "Normal" position	1. Emergency generator starts. Fire pump is now fed from generator. 2. Fire pump runs 3. Fire pump turns off after a predetermined time period 4. Fire pump power is fed from normal power and Emer. Generator shuts off	Y / N	

-- END OF TEST --

END OF SECTION 210800

SECTION 220000

PLUMBING WORK

(Trade Bid Required)

Trade Contractors on this CM at Risk project are required by law to provide Payment and Performance Bonds for the full value of their Trade Contracts, and Trade Contractors must include the full cost of the required Payment and Performance Bonds in the Bid price they submit in response to this RFB.

Bids will only be accepted from Trade Contractors pre-qualified by the Awarding Authority.

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Time, Manner and Requirements for Submitting Sub-Bids: Refer to “Request for Trade Bid- Trade Subcontract.”

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. All Work of Section 220000 – PLUMBING

2. All Work of Section 230548 – VIBRATION CONTROL & SEISMAIC RESTRAINT

3. Refer to Construction Manager’s “Request for Bid- Trade Subcontractor- Bid Package- Electrical Work,” for additional information.

4. Filed Sub-Sub Bid Class of Work: Reference Paragraph
   a. Insulation 220000 - 2.5

END OF SECTION

SECTION 220000

PLUMBING
(Filed Sub-Bid Required)

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END OF INDEX

SECTION 220000

PLUMBING
(Filed Sub-Bid Required)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Refer to Section 012300, ALTERNATES, for alternates which may affect the work of this Section.

C. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch through the Longmeadow Fire Department where work is being performed and until it is completed.

1.2 FILED SUB-BID REQUIREMENTS

A. The work of this Section in its entirety is included in the following Section:

1. Section 220000 – PLUMBING

B. The work of this Section includes the work of the following Sections in their entirety:

1. Section 230548 – VIBRATION CONTROL AND SEISMIC RESTRAINT

C. Time, Manner and Requirements for Submitting Sub-Bids

1. Sub-bids shall be submitted in accordance with the provisions of Massachusetts General Laws (Ter. Ed.), Chapter 149, Sections 44A-44I, inclusive, as amended. The time, place and manner of submission of sub-bids shall be as set forth in Document 002113-INSTRUCTIONS TO BIDDERS
2. Each sub-bid submitted for work under this Section shall be on a form furnished by the Awarding Authority, as required by Section 44F of Chapter 149 of the General Laws, as amended.
3. Each sub-bid filed with the Awarding Authority shall be accompanied by a Bid Bond or Cash or Certified check or a Treasurer's or Cashier's Check issued by a responsible bank or trust company payable to the Awarding Authority in the amount of five percent of the bid. A sub-bid accompanied by any other form of bid deposit than those specified will be rejected.

D. Sub-Sub-Bid Requirements

1. Insulation – 220000 Article 2.5.

2. Sub-bidders' attention is directed to Massachusetts General Laws, Chapter 149, Section 44F as amended which provides in part as follows:

   a. Each sub-bidder shall list in Paragraph E of the "form for Sub-bids" the name and bid price of each person, firm or corporation performing each class of work or part thereof for which (the Section of the specifications for that sub-trade) requires such listing; provide that, in the absence of a contrary provision in the Specifications, any sub-bidder may, without listing any bid price, list his/her own name in said paragraph E for any such class of work or part thereof and perform that work with persons on his/her own payroll; if such sub-bidder, after sub-bid openings, shows to the satisfaction of the awarding authority that s/he does customarily perform such class of work or the part thereof with persons on his/her own payroll and is qualified so to do. This Section of the Specifications requires that the following classes of work shall be listed in paragraph E under the conditions indicated herein

E. Reference to Drawings: Work to be performed under this Section is shown on Drawings numbered: Remaining Contract Drawings are included for reference and coordination.

F. The listing of the Contract Drawings above shall not limit the subcontractor's responsibility to determine the full extent of work of this Section as required by all Contract Drawings noted on the Contract Drawings including the Title Sheet Drawing List, the Project Manual, and Addenda.

1.3 DESCRIPTION OF WORK

A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein.

B. The work covered by this Section of the Specifications includes the furnishing of all labor and materials and in performing all operations in connection with the installation of the Plumbing Work.

C. Without limiting the generality thereof, the work to be performed under this Section includes:

1. Domestic water service to 10' outside building and/or as shown on the Drawings.
2. Complete Sanitary, Waste & Vent System to 10 ft. outside building and/or as shown on the drawings.
3. Storm drainage system including roof drains, rain leaders, and horizontal drain to 10 ft. outside foundation wall.
4. Subsoil drains, perimeter drains & footing drains to 10' outside.
5. Special Waste and Vent System (Acid Waste) including neutralizer and pH monitoring system to 10' outside.
6. Grease waste and vent system including cast iron piping within the grease trap provided under division 33.
7. Potable Cold, Hot, and Hot Water Re-circulation System.
8. Non-Potable Cold, Hot, and Hot Water Re-circulation System.
9. Natural Gas System.
10. Furnish and install domestic water heater breeching.
11. Furnish and install boiler breeching.
12. Insulation.
13. Potable & Non-Potable Water Heating Equipment.
14. Kitchen Emergency Gas Solenoid Valve
15. Fixtures and Equipment
16. Connection to Equipment Furnished by Others

17. Flushing, Sterilization, and Tests
18. Furnishing of Access Panels
19. Drilling, Coring and Cutting & Patching of holes and openings where the largest dimension thereof does not exceed 12 inches for Plumbing Piping and Equipment.
20. Provide and maintain temporary water service as directed by General Contractor. General Contractor to pay for all water use.
21. Scaffolding, Rigging, and Staging required for all Plumbing Work. Comply with Division 1 requirements.
22. Provide Seismic Restraints for all Plumbing Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference. Seismic restraints are required on all new systems whether in new or existing building.
23. Preparation of Co-ordination Drawings.
24. At Project close out the Plumbing Sub-Contractor shall provide the services of an outside firm who shall run an underground video camera, locating all drainage system lines including depth, preparing a video and identifying & correcting any problem areas. The Plumbing Sub-Contractor shall rod-out and power wash all underground drainage systems. Turn over 4 copies of the video and written report to the owner. Videos are required for the underground sanitary, garage waste, and special waste systems, main lines. Branches are not required.
25. It shall be the responsibility of this division 220000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 220000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 018000 and required to fulfill commissioning obligations.

1.4 RELATED WORK

A. The following Related Work will be performed under the designated Sections:

1. Domestic Water Service to 10' outside – DIVISION 33 – SITE WORK
2. Cutting and Patching beyond 1.03, C.20 above: SECTION 010450 - CUTTING AND PATCHING
3. Installation of Roof Drains, Flashing for vents through roof: SECTION 075100 - ROOFING & FLASHING
4. Electric Power Wiring: SECTION 260000 - ELECTRICAL
5. HVAC Equipment: SECTION 230000 - HVAC
6. Excavation and Backfill: DIVISION 31 - EARTHWORK
7. Sanitary Sewer and storm drains to 10 feet outside the foundation wall: DIVISION 33 – SITE WORK
8. Finish Painting: SECTION 099000 - PAINTING
9. Installation of Access Panels: SECTION describing material in which panel is installed.
10. Toilet Room Accessories: SECTION 108000 - TOILET ACCESSORIES
11. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
12. Food Service Equipment: SECTION 114000 FOOD SERVICE EQUIPMENT
13. Laboratory Casework and Sinks: SECTION 123450 LABORATORY EQUIPMENT

1.5 CODES, ORDINANCES, AND PERMITS

A. Perform all work in accordance with the requirements of the Town of Concord Building Department, Massachusetts State Plumbing and Fuel Gas Codes, D.E.P., A.D.A., NFPA, The Architectural Barrier Code, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform all Plumbing Work. Where the Contract Documents indicate more stringent requirements than the above Codes and Ordinances, the Contract Documents shall take precedence.

B. Refer to DIVISION 01 – GENERAL REQUIREMENTS for information regarding local municipal permit and inspection fees and utility company back charges.

1.6 SHOP DRAWING AND MATERIAL SCHEDULES

A. Refer to DIVISION 01 – GENERAL REQUIREMENTS for submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Plumbing Subcontractor.

B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Subcontractor. The Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.

C. Submit Shop Drawings for the following materials and equipment.
1. Valves, Piping, couplings and Fittings
2. Fixtures, Drains and Equipment including Supports
3. Backflow Preventers
4. Access Panels and Covers
5. Insulation
6. Drains, and Hydro Mechanical Specialties
7. Hose Bibs, Wall Hydrants
8. Hangers, Anchors, Guides, and Supports including Seismic Restraints
9. Cleanouts
10. Piping Identification System
11. Water Heating Equipment
12. Acid Neutralizer tank and monitoring equipment
13. Water heater and boiler breeching including coordinated working drawings of installation.

1.7 COORDINATION DRAWINGS

A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces (match lines).

B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.

C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 – GENERAL REQUIREMENTS of these Contract Documents.

1.8 RECORD DRAWINGS

A. Refer to DIVISION 01 – GENERAL REQUIREMENTS. The General Contractor will provide two (2) sets of black or blue line on white Drawings to the Plumbing Subcontractor, one (1) set of which shall be maintained at the site and which shall, at all times, be accurate, clear, and complete, showing the actual locations of all equipment and piping as it is being installed. The Record Drawings shall be available to the Architect/Engineer's field representative at all times.

B. At the completion of the Contract, transfer all information to a mylar sepia of the original tracings and submit three (3) sets of prints of these Record Drawings.

The Drawings and the original Contract Documents shall be used to make the final inspection of the work completed under the Contract.

C. Include in the Record Drawings any addenda, sketches, and supplementary Drawings issued during the course of construction.

D. Non-availability of Record Drawings or inaccuracies therein will postpone the final inspection until they are available.

E. After the review of the Record Drawings by the Architect, make any changes or corrections required by the Architect on the mylars. These mylars shall be certified as correct and delivered to the Architect together with two (2) sets of black line prints. Sepia vellum reproducibles will not be accepted as Record Drawings.

F. All valves shown on these Drawings shall be numbered with numbers corresponding to those on the valve charts.

G. All costs related to the foregoing requirements shall be paid by the Plumbing Subcontractor.

1.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. Provide operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals, in three-ring, loose-leaf binders, containing the following:

1. Complete Shop Drawings of all equipment.
2. Operation description for all systems.
3. Names, addresses, and telephone numbers of all suppliers of the system.
4. Preventative maintenance instructions for all systems.
5. Spare parts lists of all system components.
6. (2) Copies of video of existing & new piping.

1.10 GUARANTEE

A. Refer to DIVISION 01 – GENERAL REQUIREMENTS. Guarantee all work under this Section free from defects in workmanship and materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

1.11 DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use. The Plumbing Drawings are intended to show the main stacks and risers and may or may not necessarily show all runout piping particularly in lavatories and gang toilet areas. Contractor shall include all runout piping to all referenced and schedule fixtures, drains downspouts, etc. appearing on the Plumbing Drawings.

B. All floor drains installed on this project, including all kitchen floor drains and trough drains, shall be equipped with trap primers. The trap primer and piping is not shown on the drawings and shall be located in the filed by the Contractor as dictated by field piping conditions.

C. The Plumbing Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.

D. Refer to the Architectural, Structural, and other Mechanical and Electrical Drawings, which indicate the construction in which this Work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction proper. All measurements shall be taken at the Building.

1.12 VALVE TAGS, NAMEPLATES, AND CHARTS

A. All valves on pipes of every description shall have neat circular brass valve tags at least 1-1/2" in diameter attached with brass hook to each valve stem. Stamp on these valve tags, in letters as large as practical, the number of the valve and the service, such as "H.W., C.W., GAS", for hot water, cold water, and gas respectively. The numbers for each service shall be consecutive. Where valves are located above ACT ceilings, furnish and install valve finder ceiling tack, tack shall be minimum 7/8" diameter with 1/2" steel point, color as determined by Owner.

B. All valves on tanks and pumps shall be numbered by 3" red metal discs with white numbers 2" high, secured to stem of valves by means of small solid link brass chain, to correspond to numbers indicated for valves on the Record Drawings and on two (2) printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information such as requiring the opening or closing of another valve or valves when any one valve is to be opened and closed, and shall be prepared in form to meet approval of the Architect, and shall be framed under glass.

C. Nameplates, catalog numbers, and rating identifications shall be securely attached to Electrical and Mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

1.13 PIPE MARKER IDENTIFICATION SYSTEM

A. Mark all piping installed under this Section and located in mechanical spaces, storage rooms, above suspended ceilings, and at all Access Panels with a marking system in basic colors conforming to those specified in A.S.A. #A-13. Markings shall indicate pipe content and direction of flow. Markers shall be applied at all valves and tee joints, and on straight runs of pipe at every 20'-0" o.c. Adhesive markings are not acceptable. Markers shall be painted on under the scope of this Section or may be snap-on system.

B. Clearly mark potable and non-potable water system with 3" wide colored bands every twenty-five (25) feet on center on all piping installed whether it is concealed or exposed and also on both sides of floor and/or wall penetrations. Mark potable water green and non-potable yellow. Within 6" of each band identify with letter "Potable C.W.", Non-Potable H.W.", etc. Color of letter shall match banding. Snap-on are not to be used

1.14 SANITARY, WASTE, VENT, KITCHEN GREASE WASTE AND VENT, AND STORM SYSTEMS

A. Furnish and install complete Sanitary, Waste, Vent, Kitchen Grease Waste and Vent, and Storm Drainage Systems (all hereinafter called Drainage Systems) to convey wastes from all Soil and Waste Stacks, Fixtures, Equipment, Kitchen Fixtures, and Roof Drains as indicated and/or described in these Plans and Specifications. Urinal waste shall be 2” cast iron or sizes indicated on the drawings. Waste piping smaller than 3” shall not be used underground. The use of double "Y's" in the horizontal shall not be permitted. All piping shall be installed straight and true and located concealed within building construction.

B. All horizontal Drainage Systems Piping within the building, 3" and smaller, shall be pitched at least 1/4" per ft. in the direction of flow. Drainage Piping 4" and larger shall be pitched at least 1/8" per ft. Make changes in direction of drainage lines with 45 wyes, long turn wyes, or sweep bends.

C. Furnish and install all cleanouts indicated on the Drawings and/or where required in Drainage Pipes regardless of size so that the distance between cleanouts does not exceed 45' o.c. Cleanouts shall be installed at the base of all risers and at each change of direction.

D. Refer to drawings for termination points, which generally are connection to existing piping or to 10 feet outside the building.

E. The kitchen Grease Waste System shall be a completely separate system beginning at the exterior grease interceptor through the kitchen and vented individually through the roof. Do not connect soil lines to the grease waste nor sanitary vents to the grease vent. Furnish and install the cast iron tees and associated piping within the grease trap including 5-foot length on the outlet. All the piping within the grease trap shall be made up with caulked and leaded joints. Install an exterior cleanout as detailed at the point where the line leaves the kitchen area. Grease trap is furnished and set in place including manhole access covers by the General Contractor.

1.15 SUBSOIL DRAINAGE SYSTEM

A. Furnish and install a complete sub-soil drainage system where shown and as detailed on the Plumbing drawings and as herein specified. Excavation, fabric, stone, and backfill is furnished under Division 31.

B. Run the piping straight and true & pitched evenly at the rate of 1/32 inches per foot. Wherever crossing sanitary drainage piping run solid (non-perforated) piping for the sub-drain for a distance of 10 feet to either side of the crossing.

C. Furnish and install flush cleanouts same as specified for sanitary drainage cleanouts.

D. Co-ordinate the location and elevation of the subsoil drainage system with the General Contractor.

1.16 DOMESTIC WATER SYSTEMS (POTABLE & NON-POTABLE)

A. Furnish, install, sterilize, and test in accordance with the documents and the Plumbing Code, complete potable and non-potable Domestic Cold, Hot, and Hot Water Recirculating Systems including all piping, valves, low point drains, air chambers, hangers, insulation, backflow preventers and water heating equipment. Clearly mark the systems as provided above. This work shall start as indicated on the Drawings.

B. In general, piping shall pitch upward in the direction of flow with each branch and riser separately valved and with 1/2" hose end drain on the outlet side of the valve and at all low points in the system. Install shutoff valves for each battery of fixtures and other valves as necessary to isolate any part of each system.

C. Install pipe air chambers on hot and cold water piping to each fixture. Air chambers shall be same size as piping to fixtures by 24" high. This is in addition to all shock absorbers shown on the Drawings and/or specified.

D. Install in each toilet room provided with a floor drain a 1/2" hose bibb chrome plated complete with lock shield. The hose bibb shall be installed under a lavatory.

E. At all faucets connecting to the non-potable system whether furnished hereunder or by other sections, provide a “water unsafe” sign.

1.17 EMERGENCY TEMPERED WATER SUPPLY

A. Furnish, Install, Sterilize and Test utilizing the same materials, methods, etc. as specified above in 1.16. A tempered water supply to service all emergency showers and eye wash units. This piping shall be hung and insulated the same as above. Piping shall start at the tempering valve and shall include a time clock actuated automatic flushing and alarm system all as shown. Co-ordinate the wiring installation with the Electric Sub-contractor. Furnish and install for wiring by the Electrical Sub-Contractor a flow switch at each and every shower. Arrange piping so that either the shower or eye wash will alarm the switch.

1.18 FUEL GAS SYSTEM

A. Furnish and install a complete Natural Gas Supply System including pipe, fittings, valves, connections to all gas fired equipment requiring gas, and all accessories and incidentals as indicated or specified. Installation shall be made in accordance with the State Gas Code requirements. Piping shall be installed with an 8" long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out.

B. All horizontal Gas Piping shall be pitched not less than 1/4" in 15' to prevent traps. Pitch piping to risers. Install an 8" long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out. All horizontal branch outlet pipes shall be taken from the top or side of horizontal mains and not from the bottom.

C. Arrange with the Local Gas Company for the installation of the gas meters, services, and gas pressure regulators. Refer to section DIVISION 01 – GENERAL REQUIREMENTS for information regarding Utility Company Charges.

D. Provide seismic restraints for all gas piping per requirements of 1612.7.4 of the Mass. Building Code. Refer also to Section 230548.

E. The system is a 2 PSI elevated pressure system. Plumbing Sub-Contractor shall furnish and install all required regulators for his equipment to reduce the pressure to the appropriate range of the factory supplied equipment. The HVAC Sub-Contractor is furnishing knockdown regulators for equipment supplied by him. Co-ordinate with the HVAC Sub-Contractor and be responsible for assuring compatibility of the regulators with the following. All regulators shall be lock-up type meaning that the regulated pressure is always maintained in all ranges of flow including no flow.

1.19 SPECIAL WASTE AND VENT SYSTEM

A. Furnish and install a complete Special Waste and Vent System to convey waste from all laboratory fixtures and equipment as shown on the Drawings and/or herein specified and in accordance with Code requirements. The system shall be a complete independent system, using corrosion resistant piping from a point 10 feet outside building, running through a neutralization system and terminating independently through the roof. Furnish and install Neutralizer and Ph monitor where shown.

B. Piping shall be run as indicated on the Drawings, properly secured to the building structure with iron hangers. When any end circuit vent pipe from any fixture or line of fixtures is connected to a vent line serving other fixtures, the connection shall be sufficiently more above the floor on which the fixtures are located to prevent the use of the vent line as a waste (6" above flood rim of fixture).

C. All changes in pipe sizes and direction on Special Waste lines shall be made with 'Y's and cleanouts, reducing fittings or recessed reducers. 'Y's and 45 degree fittings or 45 degree combination fittings shall be used wherever possible.

D. All offsets shall be at an angle of not more than 45 degrees. All horizontal runs of 3" and smaller pipe shall have a pitch of 1/4" to the foot; 4" and larger pipe shall pitch at 1/8" to the foot.

E. Sanitary long sweep bends shall be used for connections to branch lines for fixtures and TY's on vertical runs of pipe only. Long turn fittings shall be used wherever conditions permit. Furnish and install cleanouts at every change in direction of Special Waste lines and where indicated on the Drawings.

F. All fixtures shall be separately trapped. All traps shall be vented unless otherwise indicated on the Drawings for fixtures in battery vent systems. Provide bow vents where island benches are not part of a battery system.

1.20 EQUIPMENT FURNISHED BY OTHERS

A. Miscellaneous items, including but not necessarily limited to the following, shall be furnished and set by others as specified in other SECTIONS of the Documents.
1. Laboratory Casework
2. Dishwashers
3. Laboratory Sinks
4. Kitchen Equipment
5. Home Economics Equipment
6. Miscellaneous Sinks
7. Photo Lab

B. Verify the extent of the connection requirements from the General and Mechanical Plans and Specifications and be responsible for: Setting in place, all such sinks and furnishing and installing trim and roughing including, but not limited to, drains, vent, water, gas, air or other plumbing piping, traps, tailpiece, nipples, escutcheons, faucets, stop valves, etc., for all items which above are not so supplied. The equipment sections specify sinks including faucets and tailpieces as well as countertop turrets for gas. Include for all sinks which are installed in cabinet work a pair of 1/2" ball valve stops (same as specified under 2.04) and a rough bronze p-trap, special waste trap, or sediment trap as required.

C. Include a "Bakelight" stamped adhesive marker at each faucet indicating "Water Unsafe" as called for in 1.16 above.

D. The Plumbing Subcontractor shall be responsible in making final connections to all equipment furnished by others to ascertain complete cross-connection prevention compliance and to furnish and install vacuum breaker and backflow preventers which may be required to be Code compliant and are not so furnished with the equipment.

E. All sinks are intended to be "Accessible" and all drain outlets on all sinks and lavatories where furnished by the Plumbing Subcontractor or the other SECTIONS shall have an off-set drain. Set all roughing tight to wall in all cases to comply with ADA Standards. Provide where required ADA insulation kits to prevent injury where a barrier is not included in the casework. Refer to Equipment Drawings.

1.21 PAINTING

A. All exposed piping is to be painted and all painting, except as noted, will be done by the Painting Subcontractor. All uncovered piping and hangers shall be thoroughly cleaned of rust, oil, etc., by the Plumbing Subcontractor and left ready to receive primer coat. Painting for pipe markings shall be done under this Section.

1.22 BREAKDOWN

A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.

B. No requisition will be approved until the breakdown is delivered to the Architect.

1.23 VISIT TO SITE

A. Prior to submitting a Bid, visit the site of work and become familiar with existing conditions. Any assumptions made are at this Subcontractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials and equipment furnished under this SECTION shall be new, unused, first quality of a manufacturer of established reputation. Each valve, fitting, section of pipe, piece of equipment, etc., shall have cast or indelibly stamped thereon the manufacturer's name, pressure rating where applicable, type, etc. Materials shall conform to Massachusetts Code as a minimum requirement and shall appear on the Massachusetts Approved Plumbing Products list.

2.2 PIPE AND FITTINGS

A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. standards.

B. All piping installed under this SECTION shall be in accordance with the following:

Service	Material
Underground Domestic Water Service	Class 52 cement lined ductile iron pipe
Underground Drainage and Vent piping	Service weight cast iron soil pipe-coated
Above ground Drainage and Vent, piping 2" and larger	No Hub cast iron soil pipe and fittings (C.I.S.P.I. 301-75)
Above ground drainage, and Vent piping 2" and smaller	Type ‘L’ hard tempered copper tubing
Trap primer piping from Primer to floor drain	Type ‘K’ soft rolled copper tubing with Swaged ends
Domestic water piping above ground (potable & non-potable)	Type ‘L’ hard tempered copper tubing
Kitchen indirect waste piping	Type ‘L’ hard tempered copper tubing coated with two (2) coats of white epoxy paint
Exposed piping at fixtures and in kitchen	Schedule 40 chrome plated red brass I.P.S.
Special Waste and Vent Piping above ground (not in plenums)	Schedule 40 electric heat fused flame retardant poly-propylene piping, fittings & traps; “George Fischer Fuseal” or approved equal

Special Waste & Vent Piping below ground	Schedule 40 electric heat fused non-flame retardant poly-propylene piping; fittings & traps, "George Fischer Fuseal" or approved equal
Gas piping above ground	ASTM A-53 Schedule 40 black steel pipe
Gas piping exposed in kitchen and at cooking island	ASTM A-53 Schedule 40 steel but painted with two (2) coats of white epoxy paint
Footing & Subsoil drainage pipe	Schedule 40 PVC non-pressure Pipe with perforations conforming to ASTM Standard D2729. Where crossing sanitary use 20 feet of non-perforated P.V.C.

C. Aboveground Water Piping:
   1. Copper Press Fittings: ½" thru 2"
   2. Manufacturers:
      a. Viega North America, 3 Alfred Circle, Bedford, MA 10730, 877-843-4262
      b. Ridge Tool Co., 400 Clark Street, Elyria, OH 44036, 800-519-3456
   3. Material:
      a. ASTM B88 and ANSI/ASME B16.22. O-rings for copper press fittings shall be EPDM.
   4. Installation, Fittings for Copper Tubing:
      a. Press connections: Copper press fittings and installation are to be made in strict accordance with the manufacturers installation instructions. All tubing is to be reamed prior to the installation of the fitting. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.
      b. All ball and check valves and strainers used on water pipe systems and installed in a copper press system are to be sweat type and specified for all water piping.

D. Fittings for underground Drainage Piping shall be service weight bell and spigot pattern C.I. soil pipe fittings. Above ground shall be no hub C.I. soil pipe fittings, Massachusetts Standard.

E. Fittings for sweat drainage piping shall be cast bronze or wrought copper of recessed drainage pattern.

F. Fittings for Type 'L' hard tempered copper tubing for potable and non-potable water piping shall be cast bronze or wrought copper sweat type, water pattern fittings.

G. Fittings for polypropylene acid-waste and acid vent (special waste system) shall be Schedule 40 polypropylene fittings with electrical resistance heat fusion joints as manufactured by George Fischer or equal. All underground pipe and fittings shall be bedded, jointed, backfilled with materials and methods outlined by the manufacturer's published instructions.

H. Fittings for gas piping 2" and smaller shall be threaded malleable iron gas pattern fittings for screwed pipe. All gas piping 2-1/2" in size and larger shall be welded and shall utilize butt welded steel pipe fittings.

I. Fittings for underground domestic water service shall be 250 psi gray iron cement lined fittings with mechanical joint ends.

J. Fittings for subsoil drainage piping shall be drainage pattern schedule 40 P.V.C. fittings with solvent end socket fittings all conforming to Mass. Standards.

2.3 JOINTS

A. Joints for underground cast iron bell and spigot soil pipe shall be made up with jute or oakum packing, caulked with 16 oz. of molten virgin pig lead per nominal inch diameter of pipe or with resilient gaskets. Above ground shall be made up of heavy duty – 4 band stainless steel clamps, and gaskets conforming to Massachusetts Code. Husky “SD 4000”, Clamp - All HI-TORQ 125, or Mission “HW”.

B. Copper tubing and sweat fittings shall be assembled with lead free solder, Silverbrite, or equal, and a non-corrosive flux recommended by the manufacturer (includes waste piping and water piping).

C. Joints between copper waste/vent tubing and cast iron shall be made with cast iron threaded fittings and copper thread by sweat fittings.

D. Joints between copper tubing and ductile iron water pipe or at flanged joints to tanks shall be made with a combination iron and brass flange with composition gasket and iron bolts.

E. Joints at water heaters or other tanks having threaded connections shall be made up with dielectric unions.

F. Joints between floor or wall flanges and fixtures shall be made with one-piece special molded neoprene gaskets which shall be furnished by the fixture manufacturer.

G. Threaded pipe joints including plastics shall be made up with teflon tape.

H. Joints on screwed gas piping shall be made up with thread compound on male threads only. Welded joints shall be made up by certified welders. All joints on piping 2-1/2" and larger shall be welded.

I. Joints on polypropylene acid waste and vent up to the outlet side of all traps shall be made up with electrical resistance fused joints utilizing manufacturer supplied power unit. Slip joints shall be used only in the final makeup connection between the trap and sink tailpiece. Vertical risers shall have vertical expansion joints at 20' intervals. Horizontal runs shall have expansion joints in accordance with manufacturer's recommendations.

J. Make up all joints on P.V.C. subsoil drainage pipe with solvent welding cement and cleaner made up in accordance with manufacturer’s detailed instructions.

2.4 VALVES

A. Furnish and install valves where indicated on the Drawings or where specified and located so that they may be operated, repaired, or replaced with a minimum effort and repacked under pressure.

B. The following list of valves is intended only as a guide for type and quality. Valves shall be as manufactured by Walworth, Apollo, Jenkins, Watts or approved equal.

Shutoff valves 2" and smaller	Apollo #70-202 through #70-208 solder end ball valves
Shutoff valves, 2-1/2" and 3"	Apollo #70-109 and #70-100
Balancing valves	Apollo# 70-222 through #70-228 with memory stop
Gate valves 4" and larger	Jenkins 651-A
Stop and waste valves 1" and smaller	Apollo #95-203 through #95-205
Check valves	Walworth #406 SJ
Gas service stops, 2" and smaller	Apollo #70-102-07 through #70-108-07 with tee handle
Gas service stops, 2-1/2" and larger	Rockwell #143 lubricated plug valve
Drain valves	Apollo #78-103-01 or #78-203-01 ball valve with cap and chain 1/2" x 3/4" hose end
Backwater Valve (Drainage Systems)	Zurn #Z1095 with extension to grade.

2.5 INSULATION

A. Insulation for all water piping and all horizontal roof leaders whether concealed or exposed shall be 1" thick, heavy density, preformed snap-on insulation equal to Johns Manville Micro-Lok HP, 850 degrees snap-on system. Insulation for cold water piping shall have a factory applied vapor barrier with ends and butts sealed with overlapping 4" sealing strips.

B. Valves, fittings, and the underside of roof drain bodies shall be insulated with pre-formed fiberglass fitting insulation cut from dense fiberglass blanket and covered with pre-molded P.V.C. fitting covers. P.V.C. covers shall overlap the adjoining insulation and shall be secured with pressure sensitive vinyl tape over a vapor barrier adhesive seal at the joints. (Note: Staples or tacks are not permitted on covers).

C. All insulation shall have self-sealing type, all service jacket (ASJ-SSL) factory applied. At exposed piping areas in locker room or gymnasium cover jacket with continuous p.v.c. jacket.

D. Sealers, solvents, tapes, and adhesives, and mastics used in conjunction with the installation of insulation under this Section shall possess the maximum possible fire safe qualities available and shall be NFPA approved.

E. Covering shall be applied over clean and dry surfaces. No covering shall be applied until after the approval of all pressure and leakage tests.

F. Insulation shall be as manufactured by Johns Manville, Inc., Owens-Corning Fiberglass Corporation SSL II-ASJ, or Knauf Insulation 1000. Insulation shall be applied by skilled insulation mechanics in a first class manner.

2.6 TRAPS

A. Furnish and install traps with cleanouts on all fixtures and equipment requiring connection to the sanitary system of the same size and material as the pipe on which they occur. Traps installed on threaded pipe shall be recessed drainage pattern.

B. Traps for the special waste system shall be Sloan polypropylene 'P' traps to suit installation. Traps shall be one-piece or shall utilize electric resistance connection. All traps shall be fitted with a cleanout plug.

2.7 DRAIN VALVES

A. It shall be possible to drain the water from all sections of the Potable and Non-Potable Hot and Cold Water Piping. Furnish and install 1/2" x 3/4" hose end ball valves with cap and chain. (see 2.04 for model no.)

2.8 SHOCK ABSORBERS

A. Furnish and install, where shown on Drawings and where required to prevent water hammer, Zurn Manufacturing Company Series Z-1700 shock absorbers, or equal, as manufactured by J.R. Smith Manufacturing Company or Josam Manufacturing Company. Installation of absorbers shall be as per manufacturer's recommendations.

2.9 PIPING ACCESSORIES

A. Pressure and Temperature Relief Valves shall be A.S.M.E. rated temperature relief 210° F. double BTU rated, self-closing, as manufactured by Watts Regulator Company or equal by Wilkins or McDonnell and Miller.

B. Vacuum reliefs shall be Watts Regulator Company #36 or equal by Wilkins or Lawler.

C. Temperature gauges shall be 4-1/2" diameter dial thermometers, any angle and range, 40 degrees F. to 240 degrees F. as manufactured by Albert A. Weiss and Sons, Inc., U.S. Gauge, or Trerice.

D. Pressure gauges shall be 4" diameter with a range of 0 to 150 psi as manufactured by U.S. Gauge.

E. Furnish and install on the Hot Water Pipe, expansion joints and anchors sized for 1-1/2" expansion per one hundred feet. Expansion joints shall be as manufactured by Flexonic Company or equal by Metraflex, Hyspan, or equal. Piping shall be anchored and guided to force the expansion in the proper direction.

F. Furnish and install where indicated on Drawings, Watts Regulator Company reducing valve and strainer combination size as indicated on the Drawing or equal, as manufactured by Donnelly Products Company or McDonnell and Miller.

G. Trap primer connections are required on all floor drains to maintain trap seal. The requirement for trap primer connections shall include all floor drains in the kitchen including trough drains furnished by others. Trap primers shall be Precision Plumbing Products, Inc. Model P/N-PR-500 prime-rite trap-primer valve or shall, where appropriate, be Zurn, Josam, Smith or equal in-line connections installed on lavatory or sink supply.

2.10 WALL HYDRANT AND HOSE BIBB

A. Wall hydrants shall be Zurn Series Z-1310 Ecolotrol cast brass 3/4" non-freeze wall hydrant with integral backflow preventer, 3/4" hose connections, polished nickel bronze face, loose key handle, brass wall sleeve, and fitted with brass locknut.

B. Hose bibb shall be T & S Brass or equal model #B-720 modified, chrome plated, 3/4" hose end, integral stop, vacuum breaker, modified with lock shield and loose tee handle.

2.11 CLEANOUTS

A. Cleanout plugs on the Sanitary System shall be of heavy cast brass of the screwed type. Plugs shall be full size up to and including 4".

B. For piping running under floor slab, cleanouts shall be brought up to just under the floor slab level. Furnish and install access cover for all floor-type cleanouts, Zurn ZN-1400 Series with scoriated nickel bronze or equal by Josam or Smith. In the garage area and at exterior locations use Zurn model #Z-1474 cleanout housing set over brass cleanout plug.

C. Cleanouts for Special Waste System shall be as follows:
1. On polypropylene pipe, use Zurn #Z9A-C04 polypropylene cleanout plug.
2. Below floor - Bring cleanout plug to below floor level and use Zurn #ZANB-1463-VP nickel bronze scoriated floor access cover mounted on Shamrock Industries concrete sleeve. See detail on drawings.

2.12 ACCESS DOORS

A. Furnish Access Doors for access to all concealed control valves, cleanouts, valves, expansion joints, and to all other concealed parts of the Plumbing System that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate SECTION of the Specifications as determined by the surface upon which the panels are mounted.

B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12" x 16"). Furnish Access Doors for each pipe space to permit thorough inspection of same. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

C. Access doors shall be prime painted and completed with cylinder lock and two (2) keys as manufactured by Acudor, Inland Steel Products Company "Milcor", or Walsh-Hannon-Gladwin, Inc., "Way Loctor". Type shall be as follows:

1.	Acoustical Tile Ceiling	Acudor AT-5020
2.	G.W.B. Surfaces	Acudor DW-5040
3.	Masonry Construction	Acudor UF-5000

4. Fire Rated Construction Acudor FB-5060

D. Access Door Shop Drawings shall be submitted to the Architect for approval.

2.13 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

A. Furnish and install all supplementary steel, channels, and supports required for the proper installation, mounting, and support of all equipment.

B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.

C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Plumbing Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.

D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90° fittings, as required to suit the construction and installation conditions.

2.14 HANGERS, ANCHORS, GUIDES, AND PIERS

A. All piping shall be supported from the Building Structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration, and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

B. The spacing for hangers for horizontal piping shall be in accordance with the following:

1. Cast Iron Soil Pipe: 5'-0" at the hubs for 5' lengths. For 10' lengths, use one (1) hanger at the hub and one (1) at midpoint of the length.
2. Copper Tubing: 6'-0" o.c. for 1-1/4" and smaller, and 10'-0" o.c. for 1-1/2" and larger.
3. Steel Pipe: 10'-0" o.c. for 1-1/2" and over; 8' - 0" for 1-1/4"; 6' – 0" for 1" and smaller.
4. Polypropylene acid waste: 4'-0" o.c.

C. Hanger rod diameter shall be as follows:

Pipe Size	Rod Diameter
1/2" thru 2"	3/8"
2-1/2" and 3"	1/2"
4" and 5"	5/8"
6"	3/4"
8" and over	7/8"

D. Vertical lines shall be adequately supported at their bases by a suitable hanger placed in the horizontal line near the riser and at every 10' interval.

E. All Hangers (including those for acid-waste) shall be adjustable Clevis Hanger. Hanger rods shall have machine threads. Malleable iron brackets of approved type shall be used along the walls. All Hangers for copper tubing shall be copper plated except where pipe is insulated, in which case, Steel Clevis Hanger and pipe shield shall be used.

F. Piping shall not be hung from the hangers of other trades.

G. Provide seismic restraints for all new piping per requirements of 1612.7.4 of the Mass Code and Section 230548.

H. Hangers shall be manufactured by Grinnell, Carpenter and Paterson, Fee and Mason, or equal.

I. Wire and strap hangers will not be permitted in this installation.

J. Install a 14 gauge metal pipe shield between pipe insulation and all pipe hangers. Hangers shall be sized so that the pipe insulation passes through the hanger and is supported on the shield.

2.15 DRAINS

A. Furnish and install all floor drains where shown on the Drawings. Furnish all roof drains for installation by the General Contractor.

B. All floor drains in flooring systems without waterproofing membranes shall have galvanized iron clamping rings with 6-pound lead flashing to bond 9" in all directions. All drains shall be checked with Architect's Drawings to determine depth of the flashing collar. Brass extension pieces shall be provided if necessary.

C. All floor drains installed on this project shall be fitted with Automatic Trap Primer Connections. Field determine appropriate location for Trap Primer valve and drain piping.

D. Drain Schedule:

1. Type "A" - Zurn #ZN-415B-P dura coated cast iron body floor drain with clamping collar and with 6" dia. nickel bronze adjustable strainer head. Trap primer connection.
2. Type "B" - Zurn #Z-550-Y-P dura coated cast iron body floor drain, sediment bucket, cast iron grate. Trap primer connection
3. Type "C" - Zurn #ZC-100-C-E-EA-GD-R cast iron body roof drain, under-deck clamp, galvanized cast iron dome secured, cast iron extension. Refer to Architect's Drawings for height of insulation.
4. Type "D" - Zurn #Z-1910-25-P cast iron body sanitary floor drain, white acid resisting interior and A.R.E. sediment bucket, 8" x 8" nickel-bronze frame and grate. Trap primer connection.
5. Type "E" - Zurn #Z-1910-25-P cast iron body sanitary floor drain, white acid resisting interior and A.R.E. sediment bucket, 6” Nickaloy Funnel. Trap primer connection.
6. Type “F” - Zurn #Z-1901-25-2 12” x 12” x 8” deep A.R.E. cast iron floor drain with A.R.E. bucket and half grate.
7. Type “G” – Zurn #ZN-1970-K-P-25, acid resistant cast iron body floor drain with trap primer connection, acid resisting sediment bucket, clamping collar, nickel bronze top, caulk bottom outlet, secured grate with vandal proof screws.
8. Type “H” – Zurn #Z-556-G-Y galvanized cast iron, adjustable top, sediment bucket fitted with Z1099-G galvanized cast iron backwater valve.

9. Type "I" - Zurn #Z-512-G-Y-VP Galvanized heavy duty cast iron body sediment bucket, heavy duty ductile iron secured grate, caulk bottom outlet.

2.16 PLUMBING FIXTURES

A. Furnish and install all fixtures and equipment, including supports, connections, fittings, and any incidentals, to make a complete installation in accordance with the Drawings and as specified.

B. The Architect shall be final judge as to whether fixtures and trim fulfill the requirements of the Specifications and as to whether they are of suitable quality.

C. All fixtures requiring hot and cold water shall have the cold water faucet on the right hand side of the fixture and the hot water faucet on the left hand side of the fixture.

D. Escutcheons shall be furnished and installed on all supplies and traps. Escutcheons shall be one (1) piece chrome plated brass with set screws.

E. All fixtures shall have the manufacturer's guaranteed label or trademark indicating first quality. All acid resisting enameled ware shall bear the manufacturer's symbol signifying acid resisting material.

F. Unless otherwise specified, faucets and all exposed fittings shall be chromium plated.

G. All supply pipes shall run in a reasonable straight vertical line from the stops to faucets. Traps shall be installed perpendicular to walls.

H. Vitreous china and acid resisting enameled fixtures shall be of one manufacturer by Kohler, American Standard, or Eljer; Trim shall be Symmons, Speakman, Chicago, or T & S Brass; Flush valves shall be Sloane, Delaney, or Zurn XL Series.

I. Note: All fixtures and fittings shall be vandal proof mounted, unless specifically noted otherwise.

J. Carefully coordinate roughing for flush valves so that the dimension from top of fixture to C-L of flush valve is a minimum of 6".

K. Special Note: There are several age groups accommodated in this building and therefore there are different mounting heights. Irrespective of the heights called for on the Documents, be responsible to re-verify in writing in field before installing any roughing for any fixture.

L. Fixture Schedule:

1. P-1 Water Closet:

   Toto CT708E vitreous china wall hung water closet complete with EcoPower TET1LN sensor operated water conserving flush valve designed for 1.28 gal./flush max.

   Toto SC534, solid plastic white, open front seat with check hinge.

   Zurn carrier as required to suit.

   Carefully coordinate with Architect's plans to fit in wall. Use Z-1209 where required by field conditions.

2. P-1A Water Closet, Accessible:

   Same as specified for P-1 except mounting height and location shall meet Accessibility Standards.

   The mounting heights are variable. Refer to Architect's Drawing and request direction in field in writing before installing.

3. P-2 Urinal:

   Sloan WES-1000, water free urinal, wall hung, wall outlet, vitreous china.

   Zurn Z-1222 concealed support.

4. P-2A Urinal, Accessible:

   Same as specified for P-2 except urinal height and location shall conform to Accessibility Standards. Note that there are variable heights and locations on this project. Refer to Architect's Drawing and request direction in field in writing before installing.

5. P-3 Wall Hung Lavatory:

   Toto LT307, wall mounted 21" x 18-1/4" vitreous china lavatory, single hole, punched for concealed armchair carrier.

   Symmons Scot S-60-H, 4" centers, metering faucet, 0.5 GPM rose spray, with Symmons 5-210-CK adjustable thermostatic mixing valve located under lavatory complete with in-line check stops. Faucet shall be set for 10 second run time.

   McGuire Model 155-WC, 1-1/4" offset drain with open grid strainer.

   McGuire Model H-167 (pair) C.P., 3/8 IPS angle supply with loose key stop.

   McGuire Model B-8902 C.P., 1-1/4" x 1-1/2" cast brass adjustable 'P' trap with cleanout and #17 ga. tubing outlet to wall.

   Zurn #Z-1231 floor mounted concealed arm chair carrier.

   Conceal all exposed roughing and electrical wiring components under lavatory with Truebro Model #2018 rigid pvc enclosure.

6. P-4 Mop Receptor:

   Stern-Williams Model MTB-2424, 24" x 24" x 10", mop service basin with stainless steel rim guard on exposed sides, 3" caulk connection, stainless steel strainer. Include caulking and sealant to seal between unit and finished wall and floor.

   Chicago 897-CP service sink fitting, polished chrome, brace to wall, integral screwdriver stops, vacuum breaker, 3/4" hose end, install a 1/2" check valve on the supplies & provide access panel.

7. P-5 Drinking Fountain with Bottle Fill:

   Filtrine 107-16-H, #4 satin finish stainless steel, flex-guard bubbler, easy touch push button actuator, with intergral push back lever valve bottle fill. ADA compliant.

   1-1/4" x 1-1/2" rough p-trap with cleanout; 1/2" ball valve stop.

8. P-6 Sink, Accessible:

   Elkay LRAD-1919-Q single bowl, 19" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 304 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

   Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

   Elkay LKAD-35 crumb cup strainer with 1-1/2" offset tailpiece and stainless steel ground seat stopper.

   1-1/2" x 2" chrome plated P-trap with cleanout, waste outlet with escutcheon.

   Pair of 1/2" x 3/8" supplies with stops and escutcheons.

   Insulate trap and supplies with LKAD-150 insulation kit.

9. P-7 Shower:

   Symmons Engineering Company #3-310 “Showeroff” package unit consisting of self-closing, concealed valve with #4-295B Fre-Flo Institutional Head, 1.5 GPM, vandal-proof mounted.

   At each shower location furnish and install a 2” Type “A” Floor Drain and a 16 oz. sheet copper drain pan turned up 6” on sides and with soldered seams.

   Refer to details on Architect’s Drawings for exact size of drain pan.

10. P-7A Shower, Accessible:

    Symmons 1-25-FSB-E-VB Safetymix Pressure Balancing Mixing valve with lever handle, factory pre-set temperature limit stops, FS hand spray unit with 1.5 GPM flow restrictor, in-line vacuum breaker, 60” flexible hose, 30” wall mounted slide bracket rod with heavy duty (250 lb) anchors.

    At each shower location furnish and install a 2” Type “A” Floor Drain and a 16 oz. sheet copper drain pan turned up 6” on sides and with soldered seams.

    Refer to details on Architect’s Drawings for exact size of drain pan.

11. P-8 Art Room Sink:

    ELKAY DLR-3322-10 single bowl, 33" x 22" x 10” deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with center outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LK-35-316 crumb cup strainer with 1-1/2" tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall.

Pair of 1/2" x 3/8" supplies with stops and escutcheons.

12. P-8A Art Room Sink, Accessible:

Elkay LRAD-1919-Q single bowl, 19" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LKAD-35-316 crumb cup strainer with 1-1/2" offset tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to wall as feasible).

Pair of 1/2" x 3/8" supplies with stops and escutcheons.

Insulate trap and supplies with LKAD-150 insulation kit.

13. P-9 Art Room Sink, Double Bowl:

ELKAY DLR-3322-10 double bowl, 33" x 22" x 10" deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with center outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LK-35-316 crumb cup strainer with 1-1/2" tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall.

Pair of 1/2" x 3/8" supplies with stops and escutcheons.

14. P-9A Art Room Sink, Double Accessible:

Elkay LRAD-3319-Q double bowl, 33" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201A-GN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LKAD-35-316 crumb cup strainer with 1-1/2” offset tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to wall as feasible).

Pair of 1/2" x 3/8” supplies with stops and escutcheons.

Insulate trap and supplies with LKAD-150 insulation kit.

15. P-10 Photo Sink:

ELKAY DLR-1919-10 single bowl, 19" x 19" x 10” deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with center outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LK-35-316 crumb cup strainer with 1-1/2” tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall.

Pair of 1/2" x 3/8” supplies with stops and escutcheons.

16. P-11 Photo Sink, Accessible:

Elkay LRAD-1919-Q single bowl, 19" x 19" x 5-1/2” deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

Chicago #201-AGN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

Elkay LKAD-35-316 crumb cup strainer with 1-1/2” offset tailpiece and type 316 stainless steel ground seat stopper.

Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to wall as feasible).

Pair of 1/2" x 3/8” supplies with stops and escutcheons.

Insulate trap and supplies with LKAD-150 insulation kit.

17. P-12 Clothes Washer:

Symmons #W-602-X Laundry-Mate Supply and Drain Fixture, recessed mounting box 1/2" hot and cold water connections, 2" waste connection, integral stops and check valves on supplies.

18. P-13 Emergency Shower/Eye Wash:

    Guardian Equipment GBF2150, recessed barrier free omni-flow combination Emergency Shower and Eye/Face Wash with ceiling mounted exposed shower head (brace to wall) and drain pan. Shower head shall be 10" stainless steel deluge shower with stay open ball valve, 30 GPM flow control, rigid stainless steel pull rod, omni-flow full face spray head with stainless steel push flag and stay open C.P. brass ball valve, flip cover on face wash.

    Furnish and install Guardian Ap275-615 flow switch which shall be wired to give an alarm by Section 260000.

19. P-14 Emergency Shower Mixing Valve:

    Provide at the location shown on the Drawings a Leonard Model TM-800-IT thermostatic mixing valve with inlet thermometers.

20. P-15 Drinking Fountain:

    Filtrine 107-14, #4 satin finish stainless steel, flex-guard bubbler, easy touch push button actuator, ADA compliant.

    1-1/4" x 1-1/2" rough p-trap with cleanout; 1/2" ball valve stop.

21. P-16 Science Classroom Sink:

    Science classroom sinks will be epoxy resin integral with the countertop by Section 064020.

    Chicago #930-GN8BVB-E7CPJKCP concealed deck faucet with 8" swing gooseneck spout with atmospheric vacuum breaker, 204 cross handles, E7FCJKCP 0.74 GPM removable serrated hose nozzle.

    Pair of 1/2" x 3/8” supplies with stops and escutcheons.

22. P-17 Science Classroom Sink, Accessible:

    Science classroom sinks will be epoxy resin integral with the countertop by Section 064020.

    Chicago #930-GN8BVBE7-317CP concealed deck faucet with 8" swing gooseneck spout with atmospheric vacuum breaker, 317 indexed wrist blade handles, E7FCJKCP 0.74 GPM removable serrated hose nozzle.

    Pair of 1/2" x 3/8” supplies with stops and escutcheons.

    Insulate trap and supplies with J-ADA-150 insulation kit.

23. P-18 Grease Interceptor:

    Zurn #Z 1170, Series 700/800, recessed mounted, recessing receiver, acid resistant coated interior and exterior, grease interceptor, complete with flow control fitting. Size as indicated on drawing.

24. P-19 Recessed Drinking Fountain:

    (Provide 2 complete units at each fixture designation)

    Elkay EDFB12C Barrier Free Recessed, Drinking Fountain, #4 satin finish stainless steel, flex-guard bubbler, push button actuator, ADA compliant.

    Coordinate installation with Architect and request direction in field in writing before installing. ***(Provide two complete units, one mounted hi and one low. Refer to Architectural drawings for mounting heights.)***

    1-1/4" x 1-1/2" rough p-trap with cleanout; 1/2" ball valve stop.

    Coordinate with Architect's Drawings.

25. P-20 Band Room Sink, Accessible:

    Elkay LRAD-1919-Q single bowl, 19" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 316 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

    Chicago #201A-GN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8" lever handles, E-2805 0.5 GPM aerator.

    Elkay LKAD-35-316 crumb cup strainer with 1-1/2" offset tailpiece and type 316 stainless steel ground seat stopper.

    Zurn #ZA-1180 acid-resistant interior and exterior fabricated steel solids interceptor mounted on floor tight to wall. (Rough as tight to wall as feasible).

    Pair of 1/2" x 3/8" supplies with stops and escutcheons.

    Insulate trap and supplies with LKAD-150 insulation kit.

26. P-21 Dual Gas Turret (180˚):

    Chicago #981-909CAGCP combination valve and turret with two ball valves at 180˚, E7TC removable serrated hose nozzle with check valve and lever handles with gas service buttons.

    Coordinate installation with Architect and request direction in field in writing before installing.

27. P-22 Control Box:

    At each Science Classroom provide a Isimet Series 4000 Utility controller with door panel mounted switches to activate remote solenoid valves to control non-potable water, natural gas, and electrical outlets at work stations. Controller shall be equipped with a key activated safety switch and door panel mounted panic button assembly. Controller shall be integrated with the building energy management system and monitored by the building alarm system.

28. P-23 Dual Gas Turret (90˚):

    Chicago #982-VR909CAGCP combination valve and turret with two ball valves at 90˚, E7TC removable serrated hose nozzle with check valve and lever handles with gas service buttons.

    Coordinate installation with Architect and request direction in field in writing before installing.

29. P-24 Science Cup Sink:

    Science cup sinks will be epoxy resin intregal with the countertop by Section 064020..

    Chicago #930-VRCP concealed deck faucet with 6" swing gooseneck spout with atmospheric vacuum breaker, 204 cross handles, E7 removable serrated hose nozzle.

    Pair of 1/2" x 3/8" supplies with stops and escutcheons.

30. P-25 Gas Turret:

    Chicago #980-VR909CAGCP single valve and turret, E7TC removable serrated hose nozzle with check valve and lever handle with gas service button.

    Coordinate installation with Architect and request direction in field in writing before installing.

31. P-26 Wash Fountain (3 Station):

    Bradley Wash Fountain Model SS-3/IR/WH TMA, express lavatory system three (3) station wall hung, Terrion, ADA compliant, color selected by Architect, complete with heavy duty wall hanger support, skirt. Include a plug in transformer for providing power to the thermostatically mixed electronic faucet. Unit to be pre-set for 30 second run time.

    2" trap and pair of 1/2" ball valve stops.

32. P-27 Master Shower Mixer:

    Symmons #5-400-B" TempControl thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid filled thermal motor with bellows element mounted out of water volume control shut off valve, bi-mental dial thermometer (3" face, range 20 degrees- 240 degrees F.), chrome plated brass pipe, fittings, and unions to cabinet limits. Cabinet to be 16 gauge body, 12 gauge door, hinged with cylinder lock, stainless steel finish cabinet and doors. Top feed units.

33. P-28 Eye Wash:

    Guardian Model G5022 deck mounted eyewash spray station with self closing squeeze valve, heads with hinged covers, 8' rubber hose and countertop mounting bracket.

    At the location shown on the drawing furnish and install a Lawler 911E emergency thermostatic mixing valve with a flow rate of .5 to 10 GPM, bypass capability and stainless steel cabinet. Mixing valve shall be located in recessed type 304, 18 ga., stainless steel cabinet with #4 finish. Include cylinder lock with two keys.

34. P-29 Exam Sink, Accessible:

    Elkay LKAD-1919-Q single bowl, 19" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 304 stainless steel sink with offset rear outlet; three (3) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

    Chicago #201A-GN8A-E2805-5CP concealed deck faucet with 8" swing gooseneck spout, 2-3/8 lever handles, E-2805 0.5 GPM aerator.

    Elkay LKAD-35 crumb cup strainer with 1-1/2" offset tailpiece and stainless steel ground seat stopper.

    1-1/2" x 2" chrome plated P-trap with cleanout, waste outlet with escutcheon.

    Pair of 1/2" x 3/8" supplies with stops and escutcheons.

    Insulate trap and supplies with LKAD-150 insulation kit.

    Furnish and Install Guardian Model G5022 deck mounted eyewash spray station with self closing squeeze valve, heads with hinged covers, 8' rubber hose and countertop mounting bracket.

    At the location shown on the drawing furnish and install a Lawler 911E emergency thermostatic mixing valve with a flow rate of .5 to 10 GPM, bypass capability and stainless steel cabinet. Mixing valve shall be located in recessed type 304, 18 ga., stainless steel cabinet with #4 finish. Include cylinder lock with two keys.

35. P-30 Kitchen Sink, Accessible:

    Elkay LKAD-1919-Q single bowl, 19" x 19" x 5-1/2" deep self rimming countertop mounted, 18 GA type 304 stainless steel sink with offset rear outlet; four (4) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

    Chicago #200-AL8-E2805-CP concealed deck faucet with 8" swing L-type spout, 2-3/8 lever handles, E-2805 0.5 GPM aerator.

    Elkay LKAD-35 crumb cup strainer with 1-1/2" offset tailpiece and stainless steel ground seat stopper.

    1-1/2" x 2" chrome plated P-trap with cleanout, waste outlet with escutcheon.

    Pair of 1/2" x 3/8" supplies with stops and escutcheons.

    Insulate trap and supplies with LKAD-150 insulation kit.

36. P-31 Kitchen Sink:

    Elkay LR-1919-Q single bowl, 19" x 19" x 7-1/2" deep self rimming countertop mounted, 18 GA type 304 stainless steel sink with offset rear outlet; four (4) hole punched faucet ledge & quick clip mounting system, sound deadening underside.

    Chicago #200-AL8-E2805-CP concealed deck faucet with 8" swing L-type spout, 2-3/8 lever handles, E-2805 0.5 GPM aerator.

Elkay LKAD-35 crumb cup strainer with 1-1/2" offset tailpiece and stainless steel ground seat stopper.

1-1/2" x 2" chrome plated P-trap with cleanout, waste outlet with escutcheon.

Pair of 1/2" x 3/8" supplies with stops and escutcheons.

Insulate trap and supplies with LKAD-150 insulation kit.

37. P-32 Master Gas Control Valve:

Acudor ARVB stainless steel box for concealed mounting constructed of 16 gauge stainless steel, 12" x 12" x 4" deep, with hinged stainless steel door, #4 satin polish, cylinder lock and loose key. Door and interior of box shall be labeled so as to indicate "Emergency Gas Shutoff". Valves shall be bronze body, double seal, full flow ball type with Buna-N seats, seals, and 'O' ring packing, 300 PSI working pressure, quarter turn on-off control.

2.17 BACKFLOW PREVENTERS

A. Main line backflow preventers, 1" and larger, shall be reduced pressure type furnished complete with shutoff valves, Massachusetts Approved, and shall be Watts #909 all bronze complete with strainer and soft seated check valve or equal by Beeco or Wilkins. Size shall be as indicated on Drawings. Mount backflow preventer 3'(+/-) above finished floor. Provide indirect waste funnel and run pipe to an air gapped discharge at sink or floor drain. Furnish a spare parts kit and parts list mounted in the vicinity of the device.

B. Prior to the installation of devices in the name of the Owner file for, pay for, and obtain all required permits and approvals for cross connection control devices from the Authority having Jurisdiction.

2.18 UNION AND NIPPLES

A. All connections between copper tubing and galvanized piping or between copper tubing and all tanks (such as water heaters, chillers, etc.) shall be made with dielectric unions and nipples.

B. All connection to Water Heaters, Meters, Pumps, and other equipment requiring maintenance or alteration shall be made up with unions. Unions on brass piping, 2" and smaller, shall be brass composition "E" in strict accordance with Federal Specification WW-U-516. On plastic piping, use unions of the same material as the piping.

C. All close and shoulder nipples shall be corresponding materials as the pipe and shall be extra heavy.

2.19 SUSPENDED ELECTRIC WATER HEATER (WH-1 & WH-2)

A. Furnish and install where shown on the drawings a RUUD Model ELDS 30 electric water heater, 30 gal. tank, two (2) 3,000 watt elements wired for simultaneous operation 208V, 3 phase, 60 cycles. Refer to detail on Drawings.

B. Provide support securely anchored to wall and structure.

2.20 INSTANTANEOUS ELECTRIC WATER HEATER (WH-3 & WH-14)

A. Furnish and install where shown on the drawings Eemax Model 820 8T instantaneous electric water heater mounted under sinks, 208V, 1 phase, 40 Amp. Refer to detail on Drawings.

B. Provide support securely anchored to wall and structure.

2.21 DOMESTIC WATER HEATER (WH-15 thru WH-19)

A. Furnish and install where shown on the Drawings for generating hot water, tankless gas fired direct vent water heater. Water heater shall be Navien Model NR-240A-NG having a maximum natural gas input of 199,000 BTU/hr. Water heater shall have the A.G.A. seal of certification and shall meet ASHRAE Standard 90 energy efficient standards. Water heater shall also be supplied with oxygen depletion sensor, overheat limiter, built-in electric blower, 120 volt power cord, and condensate neutralizer. Water heater shall be factory assembled, including a pressure regulator properly adjusted for operation on natural gas; and energy cutoff. Complete unit shall have a maximum temperature setting of 120 degrees F. and operate at a minimum flow of 0.5 GPM.

B. Furnish and install Category III stainless steel intake and vent, as specified in paragraph 2.20, up through roof or sidewall. Type “B” vent is not permitted.

2.22 DOMESTIC WATER HEATER (WH-20A & WH-20B Penthouse)

A. Furnish and install where shown on the Drawings for generating hot water, gas fired storage type water heaters. Water heater shall be A.O. Smith "Cyclone" Model BTX-80 high efficiency condensing water heaters for non-potable science room system 80 gallon storage with input of 76,000 BTU/Hr.

B. Furnish and install where shown on the Drawings for generating hot water, gas fired storage type water heaters. Water heater shall be A.O. Smith "Cyclone" Model BTH-199 high efficiency condensing water heaters for 3rd and 4th floor system and tepid water system 100 gallon storage with input of 199,9000 BTU/Hr.

C. The heater shall be suitable for sealed combustion direct venting. Heater shall be factory assembled, including a pressure regulator properly adjusted for operation on natural gas, and tested. The power burner shall be of a design that requires no special calibrations on start up. The heater shall be approved for 0” clearances to combustibles.

D. Water heater shall have the A.G.A. seal of certification and shall meet ASHRAE Standard 90 energy efficient standards. Tank shall have a working pressure rating of 150 psi and shall be equipped with a boiler-type hand-hole cleanout. Water heaters are to be ASME stamped.

E. Expansion Tank: Furnish and install as shown on plans a (12) gallon, pre-charged steel thermal expansion tank with a fixed FDA approved butyl bladder. The tank shall have a top NPT stainless steel system connection and a .301" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 150 psi working pressure. Tank shall be Wessels model number TTA-12 or approved equal.

F. Breeching: Furnish and install 4” breeching for a total equivalent distance of 120 feet as shown on plans for the domestic water heater as per manufacturer’s recommendations. Breeching shall be installed to meet all applicable federal, state and local laws, codes and requirements.

2.23 TEMPERING VALVES

A. Furnish and install where shown for temperature control at the domestic storage tank, Leonard Valve Company TM-920-RF-DT-TC High-Lo Thermostatic Water Mixing Valve, inlet check-stops, outlet volume/shutoff valve, dial thermometer, and test connection. Valves are to be furnished in rough bronze finish and are to be factory assembled and tested.

B. Furnish and install where shown for temperature control at the non-potable water heater Leonard Valve Company, Type TM thermostatic mixing valve size as indicated with integral check-stops, outlet volume/shutoff valve, and dial thermometer. Valves are to be furnished in rough bronze finish and are to be factory assembled and tested.

C. Furnish and install a 4" diameter thermometer on the outlet side of the tempering valve and where indicated on the Drawings as manufactured by U.S. Gauge Company, Powers Regulator Company, and/or Trerice Company.

2.24 RECIRCULATING HOT WATER PUMPS

A. Circulators shall be all-bronze booster type, by Bell & Gossett, Taco "Red Baron", or Thrush. Sizes as shown on the Drawings.

B. Furnish and install, where shown on the Drawings, an immersion aquastat, Honeywell #L-4006-A set to start and stop pump at a 10 degree differential temperature.

2.25 AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

A. The air intake and exhaust vents shall be of the double-wall, factory-built type for use on condensing appliances or pressurized venting systems serving Category II, III or IV appliances or as specified by the equipment manufacturer.

B. Maximum temperature shall not exceed 550ºF.

C. Vent shall be listed for an internal static pressure of 6” w.g. and tested to 15” w.g.

D. Vent shall be constructed with an inner and outer wall, with a 1” annular insulating air space.
   1. The inner wall (vent) shall be constructed of AL29-4C superferritic stainless steel, .015 thickness for 4”-12” diameters and .024 thickness for 14”-24” diameters.
   2. The outer wall (casing) shall be constructed of type 430 stainless steel, .018 thickness for 4”-12” diameters and .024 thickness for 14”-24” diameters.
   3. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.

E. All parts exposed to the weather shall be stainless steel.

F. All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.

G. Roof penetration pieces shall be UL listed and provided by the vent manufacturer.

H. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with waterproof sealant. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.

I. Vent shall terminate in accordance with installation instructions and local codes.

J. Manufacturers: Subject to compliance with requirements, provide all steel, insulated, positive pressure double wall vents of one of the following:

1. Metal-Fab, Corr/Guard Model CG
2. Selkirk Heat-Fab Saf-T Vent CI
3. Schebler eVENTplus
4. or approved equal

2.26 ACID NEUTRALIZATION SYSTEM

A. Furnish and install complete acid neutralization and PH monitoring systems including all piping, equipment, and interconnection power and control wiring from power panel to all components. Power to panel is furnished under the Electrical Section of the Specifications. Plumbing Subcontractor is responsible to furnish and install using properly licensed personnel all conduit and wiring between the panels and monitoring points. All materials and methods used for this wiring shall be consistent with the requirements of section 260000. Furnish for installation by General Contractor, access hatch detailed on drawings.

B. System shall be as manufactured by Burt Process Equipment and consist of the following:

1. Acid neutralizing tanks shall be polyethylene; Model AVS and be fitted with inlet, outlet, and vent connections as detailed on Drawings. Tanks shall be installed as shown on the drawings. Include full charge of limestone chips and a second charge of chips.
2. PH sensors shall be compatible with controller, encapsulated electrodes with automatic temperature compensation, measuring range of 0-14 PH sensitivity, and have 2 conductor shield cable.
3. PH receivers to accept 4-20 MA signal, with both digital and simulated analog display capabilities.
4. The recorders shall be strip chart type, single pen with a 2-5/16" chart width. The chart shall record for a minimum of 30 days. The unit shall operate on a 0-1 MA signal with a power requirement of 115v AC 60 Hz.
5. Receivers and recorders shall be housed in a NEMA IV styrene enclosure with single weatherproof door.
6. Control panels shall be completely pre-wired and pre-tested, NEMA IV type enclosure, wall mounted, hinged and locked front panel with components as follows:

    a. Receiver/Analyzer
    b. Strip Chart Recorder
    c. PH Out of Spec Hi/Lo Alarms
    d. System On/Off Switch
    e. Alarm Test and Silence Buttons

7. U-Trap Assembly shall be heat fusion jointed polypropylene pipe and fittings with an extension section to house the effluent PH probe.

8. All components and instrumentation for the neutralization systems shall be furnished for installation from a single source and shall be installed in strict accordance with the manufacturer's recommendations.
9. System calibration and start-up shall be included in the package provided by the manufacturer. The manufacturer shall also be responsible for conducting a training seminar for the site facilities people prior to the system being turned over to the Owner (minimum 4 hours).
10. The manufacturer, as part of his package, shall be responsible for making not less than three visits during the first year of operation to check up on the workability of the system.

2.27 GAS SOLENOID VALVE

A. Gas solenoid valve where shown on the Drawings shall be normally closed FM approved manually reset gas solenoid valve ASCO “Red-Hat” Series 8044. Valves shall operate on 120volt power and shall close the gas flow on the main gas feed to the Kitchen cooking equipment as detailed on the drawings.

2.28 TRENCH DRAIN

A. Furnish and install as shown on the Plumbing Drawings, Zurn Z-812 12” wide pre-sloped trench drainage system. Glass filled polyester fiberglass drain channel with 1/8” per foot bottom slope. All sections modular 10 foot lengths with interlocking ends complete with heavy-duty Dura-Coated steel frame with anchor studs at surface, combination anchor tabs/leveling devices at appropriate locations and extra heavy-duty cast iron grate with lockdowns.

2.29 WATER METER

A. Furnish and install water meter with inlet strainer in accordance with the standards of the Local Water Department. Coordinate the installation with the water department and include in the Plumbing Bid the cost of the meter. Refer to Part 1 of this section regarding assessments, and the like.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION METHODS

A. All work shall be installed in a first-class manner consistent with the best current practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.

B. All piping shall be installed true to line and grade in the case of underground piping. All piping above ceilings or exposed shall be grouped together, be parallel to each other, and be either parallel or perpendicular to the structure. Utilize gang hangers wherever feasible. Group all valves together where feasible.

3.2 WORK COORDINATION AND JOB OPERATIONS

A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.

B. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.

C. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Plumbing installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.

D. In case of failure to give proper information as indicated above sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.

E. Obtain from the other trades, all information relative to the Plumbing Work to be executed in conjunction with the installation of their respective equipment.

3.3 CUTTING AND CORE DRILLING

A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings

B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.

C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified. Submit procedures for cutting thru existing steel beams to Architect for review.

D. The patching of holes shall be performed by Plumbing Sub-contractor utilizing methods outlined for the finish trade involved. Holes shall be patched to the satisfaction of the Architect.

3.4 CLEANING AND PROTECTION

A. Protect all materials and equipment during shipment and so as to prevent damage. Water closets, lavatories, and sinks shall be boarded over and all other fixtures shall be protected with pasted on paper. Post notice prohibiting the use of the fixtures prior to completion. Assume full responsibility for protection of work until its completion and final acceptance.

B. Keep the premises reasonably clean at all times and remove rubbish caused by the Plumbing Work as directed by the Architect.

C. Upon completion of this work, clean all fixtures and equipment installed herein and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work.

3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

A. All piping passing through slabs, floors, walls, and partitions shall be sleeved and all such sleeves shall be furnished and installed by the Plumbing Subcontractor as detailed on the Drawings and herein specified. Set sleeves in concrete floors and walls as soon as forms are set and before concrete is poured. Core drilling openings shall have a sleeve caulked and leaded in place.

B. All pipes passing through floor, whether slab-on grade or above grade levels, shall be sleeved with sleeve extending 1" above floor. This includes all piping in toilet room pipe space, stairwells, closets, partitions and pre-cast planks.

C. All sleeves shall be Schedule 40 galvanized steel and shall be reamed. There shall be a minimum of 1" annular space between the sleeve and pipe provide greater clearance where seismic requirements dictate. Sleeves on insulated pipe shall be large enough to allow insulation to pass through sleeve. Sleeves on drywall, masonry, or concrete walls and partitions, shall be flush with wall on both sides.

D. The space between sleeve and pipe in all cases shall be filled with a U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.

E. Inserts where required shall be furnished and set by the Plumbing Subcontractor and where necessary may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1" into concrete.

F. Escutcheons: All exposed pipe, uncovered, passing through walls or floors or ceilings shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.

3.6 TESTING

A. Test all Work in the presence of the Architect and/or Engineer and as required by Local Codes.

B. After Soil, Storm, Special Waste, and Vent Piping is in place and before being buried or furred in, plug lower ends and fill the system with water up to the top of stacks. Piping is to be left tight under these conditions and water lever shall be maintained intact for the period of at least four (4) hours.

C. Test all water piping by applying a hydrostatic pressure of 150 PSIG using a pump for this purpose. Make sure that all lines are properly plugged or capped and that air has been vented before applying pressure which shall remain constant without pumping for two (2) hours at least.

D. Test gas piping per State Gas Code.

E. Any leaks in joints or evidence of defective pipe on fittings disclosed by test shall be immediately corrected by replacing defective parts with new joints or materials. No makeshift repair effected by caulking threaded pipe with lead wool, application or Wilky or patented compounds will be permitted.

3.7 CHLORINATION

A. Upon completion of the Plumbing Work, thoroughly chlorinate the entire domestic water system before putting same in service. The chlorinating agent shall be as a solution of sodium hypochlorite. Water shall be fed slowly into the new line with chlorine in the proper amount to produce a dosage of 40-50 PPM. Open and close all valves while system is being chlorinated.

B. After the sterilization agent has been applied for 24 hours, test for residual chlorine. A residual of not less than 5 PPM shall be required in all parts of the line.

C. If test show at least 5 PPM of residual chlorine, flush out system until all traces of the chemical used are removed.

3.8 INSTALLATION OF AIT INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

A. VIBRATION CONTROL AND SEISMIC RESTRAINT: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Install all steel, positive pressure, double wall gas vents in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.

C. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

D. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances.

E. Install barometric and thermostatically operated dampers in accordance with manufacturer's instructions. Locate as close to draft hood collar as possible.

F. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.

G. Temporary Closure: At ends of breechings and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are completed.

END OF SECTION

SECTION 220800
COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
2. Division 22 – Plumbing

1.03 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications. These Checklists are included in the Commissioning Plan which is in Section 4 of these specifications.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
1. Plumbing fixtures and equipment
2. Domestic hot water heaters
3. Recirculation pumps
4. Mixing Valves
5. Backflow preventers
6. Domestic Water system
7. Gas piping and distribution
8. Safety showers and eyewash stations

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.02 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
1. The system or assembly is completely installed, functional, and documented.
2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
3. All contractor-performed start-up procedures and tests are complete and documented.
4. The system or assembly is ready for the Owner to take beneficial use.

3.03 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. Plumbing fixtures and equipment
2. Domestic hot water equipment and systems

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
2. Division 22 – Plumbing

C. Checklists for this section will include:
1. Plumbing fixtures and equipment
2. Domestic hot water heaters
3. Recirculation pumps
4. Mixing Valves

5. Safety showers and eyewash stations

D. A sample functional performance test is included to show the typical scope and rigor of the process.

3.04 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.02 SUMMARY above for the sections) for review.

3.05 SAMPLE FORMS

Sample Installation Checklist

General Plumbing Pipe Installation

Schedule ID# from drawings: Piping System: _____ Location _____

Reference Specification: 15400

Reference Drawing:

Model Verification

	Specified	Submitted	Installed
Construction Standards	Miscellaneous		

Installation Checks

ID	Description	Pass/fail	Comments
1	Water piping : 1. Below ground water service piping 4" and larger shall be cement lined ductile iron pipe and fittings. 2. Above ground potable and non-potable water systems: ½"-4" Type L copper tubing with soldered joints.	☐☐ ☐☐	
2	Gas Piping: 1. Aboveground exterior and interior gas and vents shall be schedule 40 steel pipe 2. Fittings 2-1/2" and less shall be screwed type for 3" and larger shall be welded.	☐☐ ☐☐	
3	Verify sleeves are installed for pipes passing through concrete walls or floors, ½" air space around pipe to sleeve and sealed to make smoke/fire proof.	☐☐	
4	Verify that proper provisions for expansion and contraction of the hot water piping systems piping is provided by means of pipe bends, pipe offsets, swing connections or changes in direction of piping.	☐☐	
5	Verify that hose and drain valves are provided for complete draining of the system.	☐☐	
6	Verify that all high point in closed water piping systems have either equipment venting or manual vents installed.	☐☐	
7	Natural Gas piping: 1. Verify piping pitches to drains at drip legs at least 6" long. 2. Verify shut off valve is installed at each equipment connection on the downstream side of any regulators and installed in accessible location. 3. Piping is securely fastened, separately hung and not strapped or supporting other devices.	☐☐ ☐☐ ☐☐	
8	Identification: 1. Verify color coded piping identification makers on piping systems are installed including flow direction markings: markers installed: on each side of wall penetrations, at each valve, at tee fittings, and base of risers, marking spacing not to exceed. 2. Identify equipment such as pumps, compressors, water heaters, and tanks with names and equipment numbers.	☐☐ ☐☐	
9	Verify Plumbing **piping, fittings, and valves** Insulation: All interior water piping. 1. Equipment including Heat exchanger and cold water chiller. 2. All aboveground rainwater piping including drain bodies. 3. All piping in exterior furred ceiling spaces and overhangs. 4. All horizontal waste piping receiving cold water condensate	☐☐ ☐☐ ☐☐ ☐☐ ☐☐ ☐☐	

	5. All water heaters. 6. At handicapped sinks not equipped with a protective shroud.	☐☐	

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

Functional Performance Test
Plumbing Fixtures

1. Participants

Name/Representing		Participation (Testing, Witness, etc)
		Owners Representative

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

a. ☐ An as-built version of the plumbing drawing has been provided.

b. ☐ The plumbing contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. PC initials: _____. Date: _____.

c. ☐ The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _____. Date: _____.

3. Functional Testing Procedures

Test Sequence	Fixture Type	Test Procedure	Expected Results	Pass/Fail	Comments
1	Fixtures	Operate each faucet and water closet to verify water connections and pressure.	Fixtures will operate and drain. Automatic flush valves will not cause splashing. For sinks and lavs, hot water will be on the left, cold on the right.		
2	Fixtures	Measure hot water temperature at each sink and lavatory.	Water temp shall not exceed 115degrees		
3	Fixtures	Operate all Electronic Sensors	All Sensor operated fixtures shall respond as designed		

END OF TEST

END OF SECTION 220800

SECTION 230000

HVAC

(Trade Bid Required)

Trade Contractors on this CM at Risk project are required by law to provide Payment and Performance Bonds for the full value of their Trade Contracts, and Trade Contractors must include the full cost of the required Payment and Performance Bonds in the Bid price they submit in response to this RFB.

Bids will only be accepted from Trade Contractors pre-qualified by the Awarding Authority.

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Time, Manner and Requirements for Submitting Sub-Bids: Refer to "Request for Trade Bid-Trade Subcontract."

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. All Work of Section 230000 HEATING, VENTILATING & AIR CONDITIONING

2. All Work of Section 230548 – VIBRATION CONTROL & SEISMAIC RESTRAINT

3. Refer to Construction Manager's "Request for Bid - Trade Subcontractor- Bid Package-HEATING, VENTILATING & AIR CONDITIONING WORK," for additional information

4. Filed Sub-Sub Bid Class of Work:

		Reference Paragraph
a.	INSULATION	2.6, 3.7
b.	SHEETMETAL & ACCESSORIES	2.19, 2.20, 2.21, 2.22, 2.23, 3.20, 3.21, 3.23, 3.24, 3.23, 2.24
c.	AUTOMATIC TEMPERATURE CONTROL	2.28, 3.29
d.	AIR & WATER BALANCING	3.30

END OF SECTION

SECTION 230000

HVAC
(Filed Sub-Bid Required)

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SECTION 230000

HVAC
(Filed Sub-Bid Required)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the Contract and General conditions and all Sections within Division 01 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

B. Examine all other Sections of the Specifications for requirements that affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 RELATED DOCUMENTS

A. All of the Contract Documents, including Drawings, General and Supplementary Conditions and Division 1 - General Requirements, apply to the Work of this Section.

B. Carefully examine all of the Contract Documents for requirements which effect the Work of this Section. The exact scope of Work of this Section cannot be determined without a thorough review of all specification Sections and other Contract Documents.

1.3 WORK TO BE PERFORMED

A. The work described herein shall be interpreted as work to be done by the HVAC Subcontractor. Work to be performed by other trades will always be specifically referenced to that trade.

B. Furnish all staging, rigging, temporary support, labor, materials, and perform all operations in connection with the installation of the HVAC work.

C. Without limiting the generality thereof, the work to be performed under this Section includes complete new HVAC systems with the following major sub systems:
1. Low Pressure Water Piping, Insulation and accessories
2. Refrigeration Piping
3. Exhaust Fans
4. Ductwork With Insulation, Diffusers, Registers And Grilles
5. Terminal Heating Units including Unit Heaters, Fintube Radiation, Radiant Heating Panels and Convectors
6. Pumps and Accessories
7. Rooftop Penthouse Enclosures
8. Boilers
9. Rooftop HVAC Units
10. Energy Recovery Ventilation Units
11. Variable Air Volume Boxes

12. Make-Up Air Units
13. Ductless Cooling Unit Systems
14. Direct Digital Automatic Temperature Controls

D. Refer to section 230548 “Vibration Control and Seismic Restraint” for additional work to be provided under this Section 230000.

E. Refer to Section 078400 “Firestopping and Sealants” for additional work to be provided under this Section 230000.

F. It shall be the responsibility of this division 230000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 230000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 018100 and required to fulfill Section 018100 Commissioning obligations.

G. Include the following work as needed to perform the work of this section.
1. Core drilling in accordance with Section 017320 – Cutting and Patching.
2. Cutting through non masonry construction in accordance with Section 017320 – Cutting and Patching.
3. Temporary facilities, including but not limited to stairs and ladders, staging, scaffolding, chutes and hoisting in accordance with Section 015000 – Temporary Facilities and Controls.
4. Fire stop systems in accordance with Section 078400 – Fire stopping.
5. Furnish access doors and frames in accordance with Section 081110 – Hollow Metal Doors and Frames.

H. For MA-CHPS requirements refer to Section 018113.

I. For mechanical system commissioning refer to Section 018100.

J. Change all air handling unit (RTU, AHU, ERV, HVU, MAU, DCU) filters as required by Section 018119 Indoor Air Quality Management Building flush out procedures and adhere to IAQ Management Procedures referenced in Section 018119.

K. Sustainable Design Intent: Comply with project requirements intended to achieve a minimum score of 34, measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.
1. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.
2. High efficiency filters – Install MERV 13 filters in all HVAC equipment requiring filtration media immediately prior to occupancy.
3. Air intake location – Locate outside air intake openings a minimum of 25 feet from any hazard or noxious contaminants such as chimneys, plumbing vents, cooling towers, streets, alleys, parking lots, and loading docks. The distance between exhaust air or vent outlets and air intakes should be the greater of 25 feet or the distance as determined by MA State Building Code Equation 2801.2.2.2. Exception, when locating an air intake within 25 feet of a contaminant source is unavoidable, such opening shall be a minimum of 2 feet below the contaminant source and 10 feet horizontally from the nearest edge of the air intake to the nearest edge of the contaminant source. All intakes must be 6 feet above landscaped grade including soil, lawn, shrubs, or any plant life within 1.5 feet horizontally of intake.
4. Electric ignition for gas-fired equipment. Standing pilot lights in gas-fired equipment are prohibited. All gas-fired equipment shall utilize electric ignitions to light gas burners.

5. All air conditioning equipment provided under this project shall meet or exceed mechanical equipment efficiency requirements outlined by the Advanced Buildings-Benchmark Criteria. Refer to MA-CHPS 2006, Appendix A for efficiency values. If mechanical equipment efficiencies specifically listed on the drawings are higher than the Advanced Building Requirements, the higher efficiency equipment must be provided.

1.4 RELATED WORK UNDER OTHER SECTIONS

A. The following work is included in other sections. Coordinate the work of this section as required.

B. Cutting beyond the requirements as stated herein, and patching of all openings regardless of size, is specified in the respective Sections of the trade responsible for furnishing and installing similar new materials.

C. For temporary controls refer to Section 015000.

D. For flashing of vents through roof and setting of roof curbs and flashing of such, refer to Section 076200.

E. For power wiring of mechanical equipment refer to Section 260000.

F. For excavation and backfill of below grade mechanical and related systems refer to Section 312000.

G. For structural steel refer to Section 051200.

H. For firestopping not called for in this Section refer to Section 078400.

I. For finished painting of mechanical systems not called for in this Section refer to Section 099000.

J. For Food Service Equipment refer to Section 114000.

K. For interior concrete work relating to this Section refer to Section 033000.

L. For exterior concrete work relating to this Section refer to Section 033000.

M. Installation of hollow metal doors and frames refer to Section 081110 – Hollow Metal Doors and Frames.

N. For MA-CHPS requirements refer to Section 018113.

O. For mechanical system commissioning refer to Section 018100.

P. Change all air handling unit (RTU, HVU, AHU, ERV, MAU, DCU) filters as required by Section 018119 Indoor Air Quality Management Building flush out procedures and adhere to IAQ Management Procedures referenced in Section 018119.

1.5 CODES, ORDINANCES, AND PERMITS

A. Perform all work in accordance with the requirements of Concord Building Department, State of Massachusetts Building Code, 8th Edition, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform HVAC Work.

B. For information on all local connection & permit fees, Refer to INSTRUCTIONS TO BIDDERS.

C. All HVAC equipment shall be installed to meet all State, Local and Federal sound ordinances.

1.6 QUALITY ASSURANCE

A. Codes and Standards:
1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI Hydraulic Institute Standards".
2. UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 779 "Motor Operated Water Pumps".
3. ANSI Standards: Comply with ANSI A13.1 for pipe, valve, and equipment identification.
4. I=B=R Compliance: Provide boilers that have been tested and rated in accordance with Institute of Boiler and Radiator Manufacturers (I=B=R) "Testing and Rating Standard for Cast Iron and Steel Heating Boiler", and bear I=B=R emblem on nameplate affixed to boiler.
5. NFPA Compliance: Install boilers in accordance with NFPA Standard 54.
6. ASME Compliance: Construct cast iron boilers in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
7. UL and NEMA Compliance: Provide boiler ancillary electrical components and safety control devices, which have been listed and labeled UL, and comply with NEMA Standards.
8. FM Compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual System (FM).
9. IRI Compliance: Provided control devices and control sequences in accordance with requirements of Industrial Risk Insurance (IRI).
10. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
11. AGA Compliance: Provide gas controls and devices in accordance with American Gas Associates.
12. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central-Station Air Handling Units", display certification symbol on units of certified models.
13. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".
14. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
15. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA standards.
16. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.
17. ETL Compliance: Induction Units/Active Chilled Beams shall be independently tested and certified in accordance with ETL, UL or equivalent third party testing standards for thermal performance, throw and sound data.
18. MA-CHPS: Install all HVAC systems in accordance with all current requirements.

B. MSS Standard Practices: Comply with the following standards for valves:
   1. MSS SP-45: Bypass and Drain Connection Standard
   2. MSS SP-67: Butterfly Valves
   3. MSS SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends
   4. MSS SP-71: Cast Iron Swing Check Valves, Flanged
   5. MSS SP-72: Ball Valves with Flanged or Butt-Welding Ends for General Service
   6. MSS SP-78: Cast Iron Plug Valves, Flanged and Threaded Ends
   7. MSS SP-80: Bronze Gate, Glove Angle and Check Valves
   8. MSS SP-84: Steel Valves - Socket Welding and Threaded Ends
   9. MSS SP-85: Cast Iron Globe and Angle Valves, Flanged with Threaded Ends
   10. MSS SP-92: MSS Valve User Guide

C. Automatic Temperature Control Contractor Qualifications: Branch Factory Owned Authorized dealers specializing in manufacturing and installation of control system for not less than 10 years.
   1. Codes and Standards:
      a. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
      b. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.7 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise Architect in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted.

B. Where Drawings or Specifications do not coincide with manufacturers recommendations, or with applicable codes and standards, alert Architect in writing before installation.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, for between drawings and specs, this contractor shall provide that material, installation, or work which is of the more stringent.

D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a system. In cases such as this, where the contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner.

1.8 CONTRACT DRAWINGS

A. All work shown on the Drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use.

B. The HVAC Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.

C. Refer to the Architectural, Structural, and other Mechanical and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction proper. All measurements must be taken at the building.

1.9 COORDINATION DRAWINGS

A. Coordination requirements specific to the Work of this Section include the following:
1. Before materials are purchased or work is begun, the respective Subcontractor shall prepare and submit to the Architect Coordination Drawings showing the size, elevation and location of his equipment, fixtures, ductwork, conduit, and piping lines relevant to the complete system. He shall ensure that these drawings are compatible and correctly annotated and cross-referenced at their interfaces.
2. Coordination drawings are for the Contractor's and the Architect's use during construction and shall not be construed as replacing any shop or record drawings required elsewhere in the Contract Drawings.
3. All coordination drawings shall be prepared in a large enough scale to accurately identify work of each trade and in addition to each sub-contractors systems, shall also show architectural floor plan, reflected ceiling plan, and structural framing with grid identification.
4. The coordination drawing shall be prepared in AutoCAD (version 2010 or later) and shall be started by the sheet metal sub-contractor and after applying all ductwork, the drawing shall be submitted for ductwork approval by the engineer. After approval, the drawing shall be circulated to the remaining sub-contractors for application of their work.
5. During coordination drawing preparation the sub-contractors shall meet periodically to discuss overall coordination of all sub systems, and shall adjust their systems accordingly. When all drawings are complete the general contractor shall submit to the architect and engineers for review.
6. Areas of conflict that cannot be resolved between the sub-contractor must be flagged on the drawings with adequate information to assist the architect and engineer in resolving noted issues.

B. Refer to Section 013100 of these Contract Documents for general requirements and additional procedures relative to the preparation of Coordination Drawings.

1.10 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.

B. Extend all grease fittings to an accessible location.

1.11 ROUGH IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

1.12 PHASING

A. The mechanical subcontractor shall construct the subject project in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.

B. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architectural drawings.

1.13 NOTIFICATION OF RELATED TRADES

A. Notify all other trades responsible for installing chases, inserts, sleeves, anchors, louvers, etc. when ready for such installation and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.

B. Leave openings in walls for pipes, ducts, etc. for mechanical and electrical work as shown on Drawings or required by layout of mechanical or electrical systems.

1.14 MECHANICAL INSTALLATIONS

A. Coordinate mechanical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.

E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.

G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

I. Coordinate connection of mechanical system with overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.15 CUTTING AND PATCHING

A. Penetrations through construction as required for the Work of this Section:
   1. Coring: Perform all coring for required work.

2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – Unit Masonry, utilizing lintels furnished per Section 055000 – Metal Fabrications.
3. Cut openings in new and existing non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 017320 – Cutting and Patching, and 024119 – Demolition.
4. Refer to Section 024119 – Demolition for restrictions on all alterations to structural elements.

B. Patching at penetrations through construction as required for the Work of this Section:
1. Notify Masonry Sub-Contractor when plumbing work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – Unit Masonry.
2. Notify appropriate Sub-Contractors when plumbing work is complete at penetrations through non-masonry construction, and ready for patching under Sections in Division 9 - FINISHES.

C. Drilling, coring, and cutting of new and existing structures (through walls, floors, ceiling, etc.) where the largest dimension does not exceed 12" shall be by this Contractor.

D. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the existing walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved coordination drawings. All cutting or coring of structural must receive approval of the Architect prior to proceeding.

E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

F. Patching of surfaces shall be by the trade responsible for the surface penetrated.

G. Refer to related architectural sections including Section 017320 for additional reference.

1.16 SUBMITTALS

A. General: Refer to Section 013300 – Submittal Procedures for general requirements for submittal of product data, shop drawings and other materials for review by the Architect and their Consultants. The following paragraphs supplement the requirements of Section 013300.

B. Submittal of Shop Drawings, product data, and samples will be accepted only when submitted by the General Contractor. Data submitted by Sub-contractors and material suppliers directly to the Architect/Engineer will not be processed.

C. Submittal requirements specific to the Work of this Section include the following:
1. Valves
2. Meters and Gages
3. Hangers and Attachments
4. Mechanical Identification
5. Mechanical Insulation
6. Hydronic Piping
7. Refrigeration Piping
8. Boilers
9. Pumps and Accessories
10. Terminal Heating Units

11. Rooftop Units
12. Heating and Ventilation Units
13. Indoor Air Handling Units
14. Energy Recovery Ventilation Units
15. Kitchen Make-Up Air Units
16. Ductless Cooling Unit Systems
17. Power and Gravity Ventilators
18. Metal Ductwork
19. Ductwork Accessories
20. Air Outlets and Inlets
21. Sound Attenuators and Sound Lining
22. Condensate Discharge Pumps
23. Automatic Temperature Controls
24. Testing, Adjusting, Balancing, and Commissioning

D. If a Shop Drawing is not accepted after two submissions, a third submission from the same manufacturer will not be considered.

E. Check Shop Drawings and other submittals to assure compliance with contract documents before submittal to A/E.

F. Review of Shop Drawings is final and no further changes shall be considered without written application. Shop Drawings review does not apply to quantities, nor relieve this Contractor of his responsibility for furnishing materials or performing his work in full compliance with these Contract Drawings and Specifications. Review of these shop drawings shall not be considered a guarantee of the measurements of this building or the conditions encountered.

1.17 SUBSTITUTIONS

A. Refer to, Section 013310 for requirements in requesting substitutions. The following paragraphs supplement the requirements of Section 013310.

B. If materials or equipment are substituted for basis of design specified items that alter the systems shown or its physical characteristics, or which have different operating characteristics, clearly note the alterations or difference and call it to the attention of the Architect/Engineer. Contractor shall be responsible for coordinating dimensional fit of equipment that varies from basis of design equipment. Under no circumstances shall substitutions be made unless material or equipment has been successfully operated for at least three consecutive years.

C. Any modifications to the design, as a result of approving a substitution from the basis of design equipment, shall be the responsibility of this contractor. Any additional cost to this contractor or any other contractor, directly or indirectly, as a result of such substitutions, shall be the responsibility of this contractor.

1.18 PRODUCT LISTING

A. Prepare listing of major mechanical equipment and materials for the project.

B. Provide all necessary information.

C. Submit to the A/E through the General Contractor, within twenty (20) days of signing contract, this listing indicating all equipment and manufacturers, as a part of the submittal requirement. If the product list is not submitted, it will be the responsibility of the sub-contractor to submit one (1) of the three (3) named equal manufacturers.

D. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.

E. Provide products, which are compatible within systems and other connected items.

1.19 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, mode, number, serial number, capacity, operating, and power characteristics labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.20 DELIVERY, STORAGE AND HANDLING

A. Refer to Section General Conditions for delivery, storage, and handling of equipment. The following paragraphs supplement the requirements of Section General Conditions.

B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.21 RECORD DOCUMENTS

A. General: Refer to Section 017830 - Project Record Documents, for general requirements for maintaining as-built drawings and submitting final reproducible record documents. The following paragraphs supplement the above.

B. Record Drawings for the Work of this Section shall include the following: Provide electronic AutoCAD drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.

1.22 OPERATION AND MAINTENANCE DATA

A. General: Refer to Section 017700 - Close Out Procedures for general requirements for submittal of operations and maintenance manuals, training of personnel and related closeout procedures. The following paragraphs supplement the requirements of Section 017700.

B. In addition to the information required by Section 017700 for maintenance data, Closeout procedures specific to the Work of this Section include the following:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and user summer and winter operating instructions.
   3. Maintenance procedures for routine preventative maintenance and trouble-shooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Servicing instructions and lubrication charts and schedules.
   5. Provide start-up reports for all major HVAC systems and equipment, including but not limited to, boilers, all air handling equipment, ductless cooling unit systems, pumps and fans.
   6. Provide DVD recording of operation and maintenance training sessions and include as part of O & M Manual submittal. Provide indexed table of contents for DVD recording.
   7. Cooperate with Commissioning agent as required to complete system and equipment start-up reports and testing. Refer to Section 018100.

1.23 WARRANTIES

A. The contractor shall provide a one (1) year minimum warrantee on all product (unless otherwise stated in the product specification for a specific product) and labor for work under this section. Refer to general conditions for additional warranty requirements.

B. Refer to Section General Conditions and Section 017700 Contract Closeout for additional procedures and submittal requirements for warranties.

1.24 SUSTAINABLE DESIGN INTENT

A. Comply with project requirements intended to achieve a minimum score of 34, measured and documented according to the Collaborative for High Performance Schools – Massachusetts. Project scores will be verified by a third party certifier.
   1. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

B. The project intends to apply for the following credits. The project HVAC contractor shall perform all required work for the following credits as outlined in the Massachusetts Collaborative for High Performance Schools MA-CHPS Reference Guides Version 2009:

Indoor Environmental Quality		
Item	**Title/Description**	**HVAC Contractor Responsibility**
EQ P 1.1	Design ventilation systems to ASHRAE Standard 62.1-2004: Ventilation for Acceptable Indoor Air Quality.	Install and Balance systems per Design requirements.
EQ P1.2	Do not install internally insulated ductwork unless it is double-walled ductwork or includes duct liners that meet ASTM standards C1071 and C1104 for surface erosion and water vapor sorption.	All ductwork liner shall meet Prerequisite credit requirements.
EQ P 2.1	If the building or a portion of the building is to be occupied during construction, meet or exceed the Recommended Design Approaches of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) *IAQ Guideline for Occupied Buildings Under Construction,* 1995, chapter 3.	Follow SMACNA Guidelines; coordinate with GC.
Item	**Title/Description**	**HVAC Contractor Responsibility**
EQ P 2.2	Construction management – provide ventilation	Provide unit start-up with GC to provide required flush-out. Provide required filter changes.
EQ P 2.3	Construction management – post construction IAQ provide building flushout.	Provide flush-out calculation and coordinate unit start-up with GC to provide required flush-out. Provide temporary heating for areas served by air handling units which are not designed to heat 100% O.A. (i.e. re-circ RTUs if flushout occurs during winter heating season to maintain minimum 60°F space temp).

EQ P 3.1	Install dedicated exhaust for pollutant source control.	Install exhaust air systems as designed.
EQ P 3.3	Specify only electric ignitions for the following gas-fired equipment: water heaters, cooking stoves/ovens, air handling units, boilers.	Provide only electric ignitions for gas-fired equipment.
EQ P3.4	Locate outside-air intake openings a minimum of 25 feet from any hazard or noxious contaminants such as vents, chimneys, plumbing vents, exhaust fans, cooling towers, streets, alleys, parking lots, and loading docks. When locating an intake opening within 10 feet of a contaminant source is unavoidable, such opening shall be located a minimum of 2 feet below the contaminant source.	Installation shall comply with prerequisite credit requirements.
EQ P4	Prevent water accumulation by designing surface grades to slope away from buildings and building foundations in order to drain away water, snowmelt, and HVAC condensate to prevent the accumulation of water. Rain leaders and downspouts must be directed to filtration structures, storage, or rain gardens, or to daylight provided that surface drainage moves water away from buildings. Evaporative drip pans for HVAC condensate removal are prohibited.	Install condensate drains in compliance with Credit.
EQ P 5	Ensure that permanently installed filtration media have a Minimum Efficiency Reporting Value (MERV) of at least 10 except for unit ventilator systems, which shall have a MERV of at least 7.	Refer to IEQ C 5, Provide MERV-13 filters.
EQ P6	Thermal comfort – ASHRAE 55	Install mechanical systems as designed.

Item	Title/Description	HVAC Contractor Responsibility
EQ C 7	Ensure that all classrooms meet the acoustic standards of ANSI 12.60-2002.	Comply with Acoustical consultants report recommendation; install equipment meeting specified sound data. Refer to Vibration isolation specifications for additional requirements.
EQ C 4	Installed ducted air returns.	Install return ductwork per design documents.
EQ C 5	Install premium HVAC filtration.	Provide MERV-13 filters.
EQ C 6.2	Construction management – post construction IAQ provide building flushout.	Prior to flushout, replace filters with MERV 13 filters and again after flushout

Energy Efficiency		
Item	**Title/Description**	**HVAC Contractor Responsibility**
EE P 1	**(A, B, or C). Energy Efficiency Standard:** Design a school that performs significantly better than schools built to current standard practice by designing **25% or more above the ASHRAE 90.1 – 2007 standard** using A) the prescriptive criteria established by the New Buildings Institute's main resource guide: *Benchmark: Energy Benchmark for High Performance Buildings*, B) the prescriptive approach outlined in the ASHRAE standards, or C) the Total Building Approach outlined in the ASHRAE standards.	Provide equipment meeting or exceeding energy efficiency design requirements; submit shop drawings indicating equipment efficiencies.

Item	Title/Description	HVAC Contractor Responsibility
EE P 2	Provide effective and complete training and documentation on the operation and maintenance of the building systems identified in the commissioning report.	Provide Operating and Maintenance manuals for all HVAC/ATC systems and equipment. Provide owner training and video tape training sessions for all HVAC/ATC systems. Coordinate training with GC.
EE C 1	Demonstrate superior energy performance (25%-45% reduction).	Provide equipment meeting or exceeding energy efficiency design requirements; submit shop drawings indicating equipment efficiencies.
EE C 2	Minimize air conditioning.	Install HVAC and ATC system meeting design requirements.
EE C 5	Install energy management system.	Install ATC/EMS system meeting design requirements.

1.25 ENERGY REBATE PROGRAM

A. This project has been designed to incorporate equipment approved for energy rebate such as boilers, high efficiency motors, chillers, etc. Contractor shall review Utility Company requirements prior to submitting shop drawing to ascertain that submittal meets program guidelines. All submitted equipment shall meet utility company rebate program efficiency requirements. Contractor shall furnish equipment submittals, related equipment/system pricing data and all required rebate application information, forms, etc. to utility company.

PART 2 - PRODUCT

2.1 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT (Refer to section 018100 Commissioning for additional contract requirements)

A. Pursuant to Massachusetts General Laws Chapter 141, a Massachusetts Licensed electrician shall install all low voltage wiring required by this section.

B. General: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. All motors for all mechanical equipment shall be NEMA premium efficiency matching the following:

	HP	RPM	Efficiency
a.	1	1800	85.5%
b.	1.5	1800	86.5%
c.	2	1800	86.5%
d.	3	1800	89.5%
e.	5	1800	89.5%
f.	7.5	1800	91.0%
g.	10	1800	91.7%
h.	15	1800	93.0%
i.	20	1800	93.0%
j.	25	1800	93.6%
k.	30	1800	94.1%
l.	40	1800	94.1%
m.	50	1800	94.5%

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
4. Temperature Rating: Rated for 40° C. environment with maximum 50° C temperature rise for continuous duty at full load (Class F Insulation). All ratings shall be for inverter duty applications.
5. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly time spaced starts per hour for manually controlled motors.
6. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
7. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
8. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
9. Bearings:
   a. Ball or roller bearings with inner and outer shaft seals.
   b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
   c. Designed to resist thrust loading where belt drivers or other drives produce lateral or axial thrust in motor.
   d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.
10. Enclosure Type:
    a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
    b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
    c. Weather protected Type I for outdoor use, Type II where not housed.
11. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
12. Noise Rating: "Quiet".
13. Efficiency: "Premium Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, Test Method B.
14. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

C. Starters, Electrical Devices, And Wiring: (Provided By The HVAC Contractor For Each Packaged Piece Of HVAC Equipment Requiring Such):
   1. Motor Starter Characteristics:
      a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.
      b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
   2. Manual Switches shall have:
      a. Pilot lights and extra position for multi-speed motors.
      b. Overload Protection: Melting alloy type thermal overload relays.
   3. Magnetic Starters:
      a. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
      b. Trip-free thermal overload relays, each phase.
      c. Interlocks, pneumatic switches and similar devices as required for co-ordination with control requirements of Division 23 Controls Sections.
      d. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
      e. Externally operated manual reset.
      f. Under-voltage release or protection.
   4. Capacitors:
      a. Individual unit cells.
      b. All welded steel housing.
      c. Each capacitor internally fused.
      d. Non-flammable synthetic liquid impregnant.
      e. Craft tissue insulation.
      f. Aluminum foil electrodes.
      g. KVAR size shall be as required to correct motor power factor to 90% or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85% at rated load.
   5. Disconnect Switches:
      a. Fusible Switches: Fused, each phase; general duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
      b. Non-fusible Switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

2.2 VALVES

A. General:
   1. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
   2. Valves shall have rising stem, or rising outside screw and yoke stems; except, non-rising stem valves may be used where headroom prevents full extension of rising stems.
   3. Pressure and temperature ratings shall be as required to suit system pressures and temperatures.
   4. Unless otherwise indicated, provide valves of same size as upstream pipe size. Automatic control valves shall be sized by the ATC Contractor and shall not exceed a 3 PSI drop.

5. Provide the following special operator features:
   a. Handwheels fastened to valve stem, for valves other than quarter turn, by brass nut on a square-topped stem.
   b. Lever handle on quarter-turn valves 6" and smaller, except for plug valves. Provide one wrench for every 10 plug valves, and one years supply of recommended lubricant and sealant.
   c. Chain-wheel operators for valves 2-1/2" and larger installed 72" or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
   d. Gear drive operators on quarter-turn valves 8" and larger.
6. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
7. Bypass and drain connections shall comply with MSS SP-45.
8. End connections shall be as specified in the individual valves specifications.
   a. Threads: Comply with ANSI B2.1.
   b. Flanges: Comply with ANSI B16.1 for cast iron ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
9. Solder-Joint: Comply with ANSI B16.18.
   Caution: Where soldered end connection are used, use solder having a melting point below 840° F. for gate, globe, and check valves; below 421° F. for ball valves.

B. Gate Valves:
1. Gate Valves - 2" and smaller: MSS SP-80; Class 150, body and union bonnet of ASTM B 62 cast bronze, threaded ends, solid disc, bronze alloy stem with less than 6% zinc content, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

	THREADED	
MANUFACTURER	NRS	RS
Crane:	x	431UB
Jenkins:	x	47CU
Lunkenheimer:	x	3151
Nibco:	T-136	T-134
Stockham:	B-130	B-120
Milwaukee:	41M	1151M

2. Gate Valves (Hot) 2-1/2" and larger: MSS SP-70; Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

MANUFACTURER	OS&Y RS	NRS
Crane:	465-1/2	461
Jenkins:	651C	326C
Lunkenheimer:	1430	1428
Nibco:	F-617-0	F-619
Stockham:	G-623	G-612
Milwaukee:	F-2885-M	F-2882-M

C. Ball Valves:

1. Ball Valves 1" and smaller: Rated for 150 psi saturated steam pressure, 600 psi WOG pressure, 2-piece construction, bronze body conforming to ASTM B 62, standard (or regular) port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for service, threaded ends for heating hot water.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Milwaukee:	BA-100	BA-150
Conbraco (Apollo)	70-100	70-200
Crane:	9302	9322
Jamesbury:	21-1000TT	x
Jenkins:	900A	902A
Lukenheimer:	AQ311	x
Nibco:	T-585	S-585
Watts:	B-6000	B-6001
Stockham:	S-216 BR-R-T	S-216 BR-R-S

2. Ball Valves 1-1/4" to 2": Rated for 150 psi saturated steam pressure, 600 psi WOG pressure; 3-piece construction, bronze body conforming to ASTM B 62, conventional port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide solder ends for services, threaded ends for heating hot water.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Milwaukee:	BA-300	BA-350
Conbraco (Apollo):	82-100	82-200
Nibco:	T-595-Y	S-595-Y
Watts:	B-6800	B-6801
Stockham:	S-216 BR-R-T	S-216 BR-R-T

For grooved end connections use Victaulic Style 721.

D. Plug Valves

1. Plug Valves - 2" and smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.

MANUFACTURER

Rockwell: 214.
Lunkenheimer: 454.
Crane: 250.

2. Plug Valves - 2-1/2" and larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

MANUFACTURER

Rockwell: 305.
Nordstrom: 143.
Serck-Audco: LSW-133-GG.
Homestead: 612.
Victaulic Series 377

E. Globe Valves:

1. Globe Valves - 2" and smaller: MSS Sp-80; Class 150, body and union bonnet of ASTM B 62 cast bronze, threaded ends, brass or replaceable composition disc, bronze alloy stem with less than 6% zinc content, brass packing gland, "Teflon" impregnated packing, and malleable iron handwheel.

   MANUFACTURER
   Jenkins: 106-B.
   Lunkenheimer: 407.
   Nibco: T-235-Y.
   Stockham: B-22.

2. Globe Valves - 2-1/2" and larger: MSS SP-85; Class 125 iron body and bolted bonnet conforming to ASTM A 126, Class B; outside screw and yoke, bronze mounted, flanged ends, and "Teflon" impregnated packing and two-piece backing gland assembly.

MANUFACTURER	STRAIGHT BODY	ANGLE BODY
Milwaukee:	F-2981-M	x
Crane:	351	353
Jenkins:	613C	x
Lunkenheimer:	1123	x
Nibco:	F-718-B	x
Stockham:	G-512	G-515

F. Butterfly Valves:

1. Butterfly Valves - 2-1/2" and larger: MSS SP-67; 200 psi, cast iron body conforming to ASTM A 126, Class B. Valves shall have field replaceable EPDM sleeve, with aluminum bronze disc, stainless steel, and EPDM 0-ring stem seals. Sizes 2 through 6" shall have lever operators with locks, and sizes 8 through 24" shall have gear operators with position indicator. Valves on dead end service or requiring additional body strength shall be lug-wafer type, drilled and tapped.

MANUFACTURER	WAFER	
	LEVER	GEAR
Milwaukee:	x	MW-123-E
Center Line:	x	Series A
Crane:	42	x
Keystone:	100	x
Nibco:	WD-20003	WD-20003
Stockham:	LG-512-BS3E	LG-522-BS3E

	LUG	
	LEVER	GEAR
Milwaukee:	x	ML-123-E
Center Line:	x	Series LT
Crane:	44	x
Keystone:	129	x
Nibco:	LD-20003	LD-20005
Stockham:	LG-712-BS3E	LG-722-BS3E

Grooved Ends: Victaulic Series Vic 300 2-12” Victaulic series 709 14-24.

G. Check Valves:

1. Swing Check Valves - 2" and smaller: MSS SP-80; Class 150, cast bronze body and cap, conforming to ASTM B 62, horizontal swing, with a Teflon disc, and having threaded ends. Valve shall be capable of being repaired while the valve remains in the line.

   MANUFACTURER

Milwaukee:	510T
Crane:	x
Jenkins:	352C
Lunkenheimer:	230-70
Nibco:	T-433-Y
Stockham:	B-321

   For grooved connections us Victaulic Series 716, 779.

2. Swing Check Valves - 2-1/2" and larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

MANUFACTURER	CLASS 125	CLASS 175
Milwaukee:	F-2974-M	x
Crane:	373	375
Jenkins:	624C	477
Lunkenheimer:	1790	x
Nibco:	F-918B	x
Stockham:	G-931	G-940

   Victaulic Series 716, 779.

3. Wafer Check Valves - (Non-Slam): Class 250, cast iron body, replaceable lapped bronze seat, lapped and balanced twin bronze flappers and stainless steel trim. Valve shall be designed to open and close at approximately one foot differential pressure. Twin flappers shall be loaded with a stainless steel torsion spring to minimize flapper drag and assure even non-slam checking action.

   MANUFACTURER

Milwaukee:	1400-2C
Center Line:	CLC
Metraflex:	Chexx
Mission:	12HMP
Stockham:	WG970

   For grooved connection use Victaulic Series 716 and 779.

4. Lift Check Valves - 2" and smaller: Class 125, cast bronze body and cap conforming to ASTM B 62, horizontal, lift type valve, bronze disc and threaded ends. Valve shall be capable of being refitted and ground while the valve remains in the line.

   MANUFACTURER HORIZONTAL

   Milwaukee: 544
   Hammond: 901
   Jenkins: 117C
   Lunkenheimer: 2142

2.3 METERS AND GAGES

A. Glass Thermometers
   1. General: Provide glass thermometers of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
   2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long.
   3. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
   4. Tube and Capillary: Mercury filled, magnifying lens, 1% scale range accuracy, shock mounted.
   5. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
   6. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
   7. Range: Conform to the following:
      a. Hot Water: 30° - 240° F. with 5° F. scale.
   8. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following:
      a. Ernst Gage Co.
      b. Marshalltown Instruments, Inc.
      c. Trerice (H.O.) Co.
      d. Weis Instruments, Inc.
      e. Or Equal.

B. Thermometer Wells
   1. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2" extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.
   2. Manufacturer: Subject to compliance with requirements, provide glass thermometers of one of the following:
      a. Ernst Gage Co.
      b. Marshalltown Instruments, Inc.
      c. Trerice (H.O.) Co.
      d. Weis Instruments, Inc.
      e. Or Equal.

C. Pressure Gages
   1. General: Provide pressure gages of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
   2. Type: General use, 1% accuracy, ANSI B40.1 grade A, phosphor bronze bourdon type, bottom connection.
   3. Case: Drawn steel or brass, glass lens, 4-1/2" diameter.
   4. Connector: Brass with 1/4" male NPT. Provide protective siphon when used for steam service.

5. Scale: White coated aluminum, with permanently etched markings.
6. Range: Conform to the following:
   a. Water: 0 - 100 psi.
      50 - 300 psi.
7. Manufacturer: Subject to compliance with requirements, provide pressure gages of one of the following:
   a. Ametek/U.S. Gauge.
   b. Marsh Instrument Co., Unit of General Signal.
   c. Marshalltown Instruments, Inc.
   d. Trerice (H.O.) Co.
   e. Weiss Instruments, Inc.
   f. Or Equal.

D. Pressure Gage Cocks
1. General: Provide pressure gage cocks between pressure gages and gage tees on piping systems. Construct gage cock of brass with 1/4" female NPT on each end, and "T" handle brass plug.
2. Siphon: 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end.
3. Manufacturer: Same as for pressure gages.

E. Annular Element Flow Meters And Fittings
1. General: Provide as indicated, flow metering elements constructed of brass and stainless steel, equipped with readout valves to facilitate connecting of differential pressure meter to flow meter. Equip each readout valve with integral shut-off valve designed to minimize system fluid loss during monitoring process. Provide ball type brass isolation valve. Provide calibrated nameplate with flow meter detailing its flow range through range of differential head pressures. Each element shall be of the bi-directional type having four diametrically opposed sensing ports on both upstream and downstream sides in order to ensure average velocity and static pressure. Elements shall be capable of operating at a maximum temperature of 300E F. and maximum pressure of 250 psig.
2. Manufacturer: Subject to compliance with requirements, provide flow meters of one of the following:
   a. Preso Industries Corp.
   b. Meriam Instrument.
   c. Dieterich Standard Corp.
   d. Or Equal.

F. Calibrated Balance Valves
1. General: Provide as indicated, calibrated balance valves equipped with readout valves to facilitate connecting of differential pressure meter to balance valves. Equip each readout valve with integral EPT check valve designed to minimize system fluid loss during monitoring process. Provide calibrated nameplate to indicated degree of closure of precision machined orifice. Construct balancing valve with internal EPT 0-ring seals to prevent leakage around rotating element. Provide balance valves with preformed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment.
2. Manufacturer: Subject to compliance with requirements, provide calibrated balance valves of one of the following:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Taco, Inc.
   c. Armstrong Pumps Inc.
   d. Tour and Andersson
   e. Or Equal.

2.4 HANGERS & ATTACHMENTS (Refer to section 230548 for coordination)

A. Horizontal-Piping Hangers and Supports:
1. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacture for each piping service. Select size of hangers and supports to exactly fit pip size for bare piping, and to insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
   a. Adjustable Steel Clevises Hangers: MSS Type 1.
   b. Steel Pipe Clamps: MSS Type 4.
   c. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
      1) Plate: Unguided type.
      2) Plate: Guided type.
      3) Plate: Hold-down clamp type.
   d. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
   e. Pipe Stanchion Saddles: MSS Tube 37, including steel pip base support and cast-iron floor flange.
   f. Adjustable Pipe Saddle Supports: MSS Type 38, including steelpipe base support and cast-iron floor flange.
   g. Single Pipe Rolls: MSS Type 41.
   h. Adjustable Roller Hangers: MSS Type 43.
   i. Pipe Roll Stands: MSS Type 44.
   j. Pipe Rolls and Plates: MSS Type 45.
   k. Adjustable Pipe Roll Stands: MSS Type 46.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
   a. Carpenter and Patterson, Inc.
   b. Corner & Lada Co., Inc.
   c. Elcen Metal Products Co.
   d. Fee & Mason Mfg. Co.; Div. Figgie International
   e. ITT Grinnel Corp.
   f. Or Equal.

B. Vertical-Piping Clamps:
1. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps, complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
   a. Two-Bolt Riser Clamps: MSS Type 8.
   b. Four-Bolt Riser Clamps: MSS Type 42.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
   a. Carpenter and Patterson, Inc.
   b. Corner & Lada Co., Inc.
   c. Elcen Metal Products Co.
   d. Fee & Mason Mfg. Co.; Div. Figgie International
   e. ITT Grinnel Corp.
   f. Or Equal.

C. Hanger-Rod Attachments:
   1. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-pipe hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
      a. Steel Turnbuckles: MSS Type 13.
      b. Swivel Turnbuckles: MSS Type 15.
      c. Malleable Iron Sockets: MSS Type 16.
   2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
      a. Carpenter and Patterson, Inc.
      b. Corner & Lada Co., Inc.
      c. Elcen Metal Products Co.
      d. Fee & Mason Mfg. Co.; Div. Figgie International
      e. ITT Grinnel Corp.
      f. Or Equal.

D. Building Attachments:
   1. General: Except as otherwise indicate, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
      a. Concrete Inserts: MSS Type 18.
      b. Top Beam C-Clamp: MSS Type 19.
      c. Side Beam or Channel Clamps: MSS Type 20.
      d. Center Beam Clamps: MSS Type 21.
      e. Welded Beam Attachments: MSS Type 22.
      f. C-Clamps: MSS Type 23.
      g. Top Beam Clamps: MSS Type 25.
      h. Side Beam Clamps: MSS Type 27.
      i. Steel Beam Clamps W/Eye Nut: MSS Type 28.
      j. Linked Steel Clamps W/Eye Nut: MSS Type 29.
      k. Malleable Beam Clamps: MSS Type 30.
      l. Steel Brackets: One of the following for indicated loading:
         1) Light Duty: MSS Type 31.
         2) Medium Duty: MSS Type 32.
         3) Heavy Duty: MSS Type 33.
      m. Side Beam Brackets: MSS Type 34.
      n. Plate Lugs: MSS Type 57.
      o. Horizontal Travelers: MSS Type 58.
   2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
      a. Carpenter and Patterson, Inc.
      b. Corner & Lada Co., Inc.
      c. Elcen Metal Products Co.
      d. Fee & Mason Mfg. Co.; Div. Figgie International
      e. ITT Grinnel Corp.
      f. Or Equal.

E. Saddles and Shields:
1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
2. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
3. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
4. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
   a. Elcen Metal Products Co.
   b. Pipe Shields, Inc.
   c. Carpenter Patterson, Inc.
   d. ITT Grinnel Corp.
   e. Or Equal.

F. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML 1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A 36.
3. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
5. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.5 MECHANICAL IDENTIFICATION (Refer to section 018100 Commissioning for additional contract requirements)

A. Plastic Pipe Markers:
1. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
2. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. 4. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).
   d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

B. Application: Provide pipe labels for the following piping system:
1. Heating hot supply and return.

2. Refrigerant liquid and suction.
3. Condensate drain.

C. Valve Tags:
1. Brass Valve Tags: Provide 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
   a. Provide 1-1/2" diameter tags, except as otherwise indicated.
   b. Provide size and shape as specified or scheduled for each piping system.
   c. Fill tag engraving with black enamel.
2. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

D. Valve Schedule Frames:
1. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

E. Plastic Equipment Markers:
1. General: Provide manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
   a. Green: Cooling equipment and components.
   b. Yellow: Heating equipment and components.
   c. Yellow/Green: Combination cooling and heating equipment and components.
   d. Blue: Equipment and components that do not meet any of the above criteria.

2. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Equipment label “ID” from schedules.
   b. Design capacity from schedules.

3. Size: Provide approximate 2-1/2" x 6" markers for each piece of equipment.
4. Application: Provide equipment labels for the following equipment:
   a. Boilers
   b. Pumps
   c. Expansion Tanks
   d. Rooftop Units (RTU)
   e. Heating and Ventilation Units (HVU)
   f. Energy Recovery Ventilation Units (ERV)
   g. Indoor Air Handling Units (AHU)
   h. Kitchen Make-Up Air Units (MAU)
   i. Exhaust Fans
   j. Air Cooled Condensing Units
   k. Heating and Ventilation Units
   l. Terminal Heating Units equipped with fans
   m. Ductless Cooling Unit Systems
   n. Combustion Exhaust and Air Fan Systems

2.6 MECHANICAL INSULATION

A. Piping Insulation Materials:
1. Fiberglass Piping Insulation: ASTM C 547, Class 45 required.
   a. Class 1 for use to 450 degrees F; Class 2 for use to 650 degrees F; Class 3 for use to 1200 degrees F.
2. Flexible Unicellular Piping Insulation: ASTM C 534, Type as required.
   a. Type I - tubular; Type II - sheet. For use between -40 degrees F and 200 degrees F.
3. Jackets for piping Insulation: ASTM C 921, with vapor barrier for piping with temperatures below ambient.
4. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
5. Encase straight pipe insulation, where exposed in occupied areas, with one piece 20-mil thick PVC Jacketing. Fasten and seal as per manufacturer's recommendations.
6. Encase exterior piping insulation with aluminum jacket with weather-proof construction.
7. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
8. Adhesives, Sealants and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

B. Piping Insulation Application and Thickness:
1. Application: Cold Piping (40 Degrees F to Ambient):
   a. Insulate the following cold HVAC piping systems:
      1) HVAC make-up water piping.
      2) Air conditioner condensate drain piping.
      3) Refrigerant liquid and suction piping.
   b. Insulate HVAC make-up condensate drain and refrigerant piping system specified above with the following type and thickness of insulation:
      1) Fiberglass: 1 1/2" thick for all pipe sizes.
2. Application: Hot HVAC Piping (to 200 Degrees F)
   a. Insulate the following hot HVAC piping systems
      1) HVAC hot water supply and return piping.
      2) Hot gas refrigerant piping.
   b. Insulate each piping system specified above with the following type and thickness of insulation:
      1) Fiberglass: 1-1/2" thick for pipe sizes up to and including 1 ½”, 2” thick for all 2” pipe and larger.
      2) Flexible Unicellular: (Refrigerant piping only) 1" thick.
3. Insulation of Piping Exposed to Weather: Protect outdoor insulation from weather by installing outdoor protective finish aluminum jacketing installed as recommended by the manufacturer. Insulation thickness shall be increased by one size versus specified pipe insulation thickness.

C. Ductwork Insulation Materials:
1. Rigid Fiberglass Ductwork Insulation (R-8): ASTM C 612, Class as required.

   CLASS 2 - 400 DEGREES F; 4 LBS./FT3.
   CLASS 3 - 850 DEGREES F; 12 LBS./FT3.
   CLASS 4 - 1000 DEGREES F; 12 LBS./FT3.
   CLASS 5 - 1800 DEGREES F; 20 LBS./FT3.

2. Flexible Fiberglass Ductwork Insulation (R-5): ASTM C 512, Class as required.

   CLASS 2 - 400 DEGREES F; .75 LBS./FT3.
   CLASS 3 - 850 DEGREES F; 1.5 LBS./FT3.

3. Jackets for Ductwork Insulation: ASTM C 921, with vapor barrier.
4. Ductwork Insulation Accessories: Provide staples, bands, wire, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
5. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

D. Ductwork Insulation Application and Thickness:
   1. Application: Ventilation and AC System Ductwork:
      a. Insulate the following ductwork:
         1) Outdoor air intake ductwork between air entrance and air handling unit inlet.
         2) HVAC supply ductwork between HVAC unit discharge and room terminal outlet.
         3) Insulate neck and bells of supply diffusers.
         4) HVAC return ductwork between room terminal inlet and HVAC unit inlet; except omit insulation on return ductwork located in return air ceiling plenums.
         5) HVAC plenums and unit housing not pre-insulated at factory or lined.
         6) Exhaust ductwork between in-line exhaust fan and point of exit in building.

      b. Insulate each ductwork system specified above with the following type and thickness of insulation:
         1) Rigid Fiberglass: In machine rooms, fan rooms, and mechanical spaces insulate all supply air, return air and outside air ductwork with 2" thick rigid (minimum R-8). All exposed outdoor ductwork in occupied areas shall be insulated internally with same thickness and material.
         2) Flexible Fiberglass: 1-1/2 thick (minimum R-5), application limited to concealed locations which shall include above ceilings, in chases, shafts etc.
         3) All outside air ductwork shall be 2" rigid (R-8).

   2. Application: Hot Ductwork (Above Space Temperature):
      a. Insulate the following hot ductwork:
         1) Kitchen hood exhaust ductwork.
      b. Insulate each ductwork system specified above with the following type and thickness of insulation:
         1) All kitchen exhaust ductwork shall be insulated with (2) 1 ½" layers of calcined kaolin similar to Nelson "FSB" flame-shield blanket to achieve a 2 hr. rating.

   3. Application: Laboratory Exhaust Duct Laboratory exhaust ductwork shall be provided with (2) 1 ½" layers of calcined kaolin similar to Nelson "FSB" flame-shield blanket to achieve a 2 hr. rating when ductwork is not routed in a rated enclosure. refer to architectural plans for locations of laboratory exhaust ductwork and architectural enclosure details.

E. Equipment Insulation Materials:
1. Rigid Fiberglass Equipment Insulation (R-8): ASTM C 612, Class as required.

CLASS 2 - 400 DEGREES F; 12 LBS./FT3.
CLASS 3 - 850 DEGREES F; 12 LBS./FT3.
CLASS 4 - 1000 DEGREES F; 12 LBS./FT3.
CLASS 5 - 1800 DEGREES F; 20 LBS./FT3.

2. Flexible fiberglass Equipment Insulation (R-5): ASTM C 553, Type and Class as required.

TYPE I - RESILIENT, FLEXIBLE;
CLASS B-1 - 0.65 LBS./FT3
CLASS B-2 - 0.75 LBS./FT3
CLASS B-3 - 1.00 LBS./FT3
CLASS B-4 - 1.50 LBS./FT3
CLASS B-5 - 2.00 LBS./FT3
CLASS B-6 - 3.00 LBS./FT3

TYPE II - FLEXIBLE; CLASS F-1 - 4.50 LBS./FT3
TYPE III - SEMIRIGID; CLASS F-2 - 4.50 LBS./FT3

3. Flexible Unicellular Equipment Insulation: ASTM C 534, Type as required.

TYPE I - TUBULAR.
TYPE II - SHEET.

4. Jacketing material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.
5. Equipment Insulation Compounds; Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.
6. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

F. Equipment Insulation Application and Thickness:
1. Application: Equipment (Below Space Temperature):
   a. Insulate the following equipment:
      1) Drip pan under chilled equipment.
      2) Hot water expansion tank and air separators
   b. Insulate each item of equipment specified above with the following type and thickness of insulation:
      1) Fiberglass: 2" thick

2.7 HYDRONIC PIPING AND ACCESSORIES

A. Manufacturer: Subject to compliance with requirements, provide piping system products from one of the following:
1. Grooved Mechanical Joint Pipe, Fittings and Couplings:
   a. Victaulic Company of America.
2. Pump Discharge Valves (Triple-Duty Valve):
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Taco, Inc.

e. Or Equal.

3. Safety Relief Valves:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Spirax Sarco.
   d. Watts Regulator Co.
   e. Or Equal.
4. Pressure Reducing Valves:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Taco, Inc.
   e. Or Equal.
5. Air Vents (Manual and Automatic):
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Armstrong Machine Works.
   c. Hoffman Specialty ITT; Fludi Handling Div.
   d. Spirax Sarco.
   e. Or Equal.
6. Air Separators:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Taco, Inc.
   e. Or Equal.
7. Diaphragm-Type Compression Tanks:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Or Equal.
8. Pump Suction Diffusers:
   a. Bell & Gossett ITT; Fluid Handling Div.
   b. Amtrol, Inc.
   c. Armstrong Pumps, Inc.
   d. Taco, Inc.
   e. Victaulic (style 731)
   f. Or Equal.
9. Chemical Feeder:
   a. Dearborn USA.
   b. Vulcan Laboratories, Subsidiary of Clow Corp.
   c. York-Shipley, Inc.
   d. Or Equal.
10. Basket Strainers:
   a. Crane Co.
   b. Metraflex Co.
   c. Spirax Sarco.
   d. Victaulic Company of America.
   e. Or Equal.

B. Pipe and Tubing Materials
   1. Copper Tubing: ASTM grade B 88, Type L hard drawn temper copper tubing.
   2. Copper Tubing: ASMT grade B 88, Type K, annealed copper tubing.
   3. Steel Pipe: ASTM A-53 grade B, Schedule 40, seamless, black steel pipe, beveled ends.

C. Fittings
1. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
3. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
4. Grooved Mechanical Fittings: ASTM A 106, steel fittings with grooves or shoulders designed to accept grooved end couplings.
5. Grooved Mechanical Couplings (Zero Flex Only): Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
6. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
7. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.
8. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
9. Steel Flanges and Flanged Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
   a. Material Group: 1.1.
   b. End Connections: Butt Welding.
   c. Facings: Raised face.
10. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead, for condenser water and make-up water and drain piping.
11. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony, for heating hot water and low pressure steam piping.
12. Brazing Filler Metals: AWS A5.8.
    WARNING: Some filler metal contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
13. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.
14. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250 deg. F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4" misalignment.

D. Pipe Sleeves and Escutcheons
1. General: Provide schedule 40 black steel or 18 gage galvanized pipe sleeve large enough to accept pipe along with specified pipe insulation at each point where pipe penetrates a wall or floor. Sleeve shall be large enough to allow for free movement of pipe however minimized to prevent leakage of smoke and fire during a fire emergency. For all piping exposed to view provide a chrome plated escutcheon that will surround insulation where applicable on pipe for a neat finished appearance. Where piping is concealed above ceilings no escutcheons are required.

E. Special Duty Valves
1. General: General duty valves (i.e., gate, check, ball, and butterfly valves) are specified in Division 23 Section "Valves" Special duty valves are specified in this Article by their generic name; refer to the drawings for specific applications of these valves.
2. Pump Discharge Valves (Triple-Duty Valve): 175 PSIG working pressure, 300° F. maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.

3. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.
4. Safety Relief Valves: 125 psig working pressure and 250° F. maximum operating temperature: designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and BTU capacity.
5. Combined Pressure/Temperature Relief Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment. Safety relief valve designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber; 125 psig working pressure and 250° F. maximum operating temperature. Select valve to suit actual system pressure and BTU capacity. Provide with fast fill feature for filling hydronic system.

F. Hydronic Specialties:
1. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 250° F. operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8" discharge connection and 1/2" inlet connection.
2. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240° F. operating temperature; and having 1/4" discharge connection and 1/2" inlet connection.
3. Diaphragm-Type Compression Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375° F. maximum operating temperature. Separate air charge from flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.
4. Pump Suction Diffusers: Cast-iron body, with threaded connections for 2" and smaller, flanged connections for 2-1/2" and larger; 175 psig working pressure, 300° F. maximum operating temperature; and complete with the following features:
    a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
    b. Cylinder strainer with 3/16" diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
    c. Disposable fine mesh strainer to fit over cylinder strainer.
    d. Permanent magnet, located in flow stream, removable for cleaning.
    e. Adjustable foot support, designed to carry weight of suction piping.
    f. Blowdown tapping in bottom; gage tapping in side.
5. Chemical Feeder: (Provide one (1) for each piping system). Bypass type chemical feeders of 5 gallon capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.
    a. Chemicals shall be specially formulated to prevent accumulation of scale and corrosion in piping system and connected equipment.
6. Y-Pattern Strainers: Cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2" and larger, threaded connections for 2" and smaller, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.

7. Basket Strainers: High tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.

2.8 REFRIGERANT PIPING

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for refrigeration piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of materials and products are indicated, selection is Installer's option.

B. Material: Provide pipes and pipe fittings in accordance with the following listing:
1. Tube Size 4-1/8" and Smaller: Copper tube; Type ACR, hard-drawn temper; wrought-copper, solder-joint fittings; brazed joints.

C. Soldered Joints: Solder joints using silver-lead solder, ASTM B32, Grade 96 TS.

D. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCUO-4 for brazing filler metal.

E. Piping Specialties: Provide piping specialties complying with Division 23 "Hydronic Piping" in accordance with the following listing:
1. Pipe escutcheons.
2. Drip pans.
3. Sleeves.
4. Sleeve seals.

F. Refrigerant Valves: Special valves required for refrigerant piping include the following types.
1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 degrees F (149 degrees C) temperature rating, 500 PSI working pressure.
2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided piston and stainless steel spring, 250 degrees F (121 degrees C) temperature rating, 500 PSI working pressure.
3. Manufacturer: Subject to compliance with requirements, provide globe and check valves of one of the following:
   a. Henry Valve CO.
   b. Parker Hannifin Corp.; Refrigeration & Air Cond. Div.
   c. Sporlan Valve Co.
   d. Or Equal
4. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz., UL-listed, ½" conduit adapter, 250 degrees F (121 degrees C) temperature rating, 400 PSI working pressure.
5. Manufacturer: Subject to compliance with requirements, provide solenoid valves of one of the following:
   a. Alco Controls Div.; Emerson Electric Co.
   b. Automatic Switch Co.
   c. Sporland Valve CO.
   d. Or Equal
6. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 PSI working pressure.

7. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200 degrees F (93 degrees C) temperature rating, 500 PSI working pressure.
8. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 PSI working pressure.
9. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron coverplate with steel cap screws, replaceable filter-drier core, 500 PSI working pressure.
10. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
11. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
12. Manufacturer: Subject to compliance with requirements, provide refrigeration accessories of one of the following:
    a. Alco Controls Div.; Emerson Electric CO.
    b. Henry Valve CO.
    c. Parker-Hannifin Corp.; Refrigeration & Air Conditioning Div.
    d. Sporlan Valve Co.
    e. Or Equal.

G. Basic Vibration Control: Provide vibration control products as required in accordance with the following listing:
1. Isolation hangers.
2. Riser isolators.
3. Riser support isolators.
4. Flexible pipe connectors.

2.9 ROOFTOP PENTHOUSE ENCLOSURES (BOILER ROOM)

A. Double wall acoustical enclosure
1. All mechanical and electrical equipment shall be housed inside a factory fabricated double wall enclosure. The enclosure shall be fabricated by the same manufacturer as the steel base, pipe work and pipe supports to ensure structural integrity of the entire Packaged System. The use of a self-framing or sheet metal building that does not incorporate a structural steel wall framework, structural steel roof framework, lifting lugs is not acceptable.
2. The components of the enclosure shall be:
    a. Floor: shall be a minimum of 3/16” steel checker plate. When used with an enclosure, the perimeter of the floor shall be broken upward 1.5” to form a water dam and the corner seams shall be seal welded to form a watertight floor. The use of z-bar is permitted provided that the z-bar is continuously seam welded, not caulked.
    b. Exterior Panels: Wall and roof panels shall be fabricated from 16ga. satin coat steel and sealed with an individual strip of ½” x 3/8” tape sealer. Wall panel shall be 2” thick with seams turned inward to provide flush exterior finish. Exterior roof panels shall be 4” thick. Wall and roof exterior panels shall wrap around wall and roof structural framework to ensure thermal break.
    c. Structural Steel Base: When used with an enclosure, the perimeter members shall be, at a minimum, 8”x6”x0.188” hollow structural steel tube (HSS) and shall enable the installing contractor to shim the unit at 12 foot spans on site. The use of a c-channel or flanged steel perimeter is permitted provided the base is at least 12” deep.

d. Wall and Roof Structural Steel Framework: an integral structural steel framework of hollow structural steel shall support the walls and roof. The framework members shall be, at a minimum, 3"x3"x0.188" HSS at 10-foot centers. The roof steel shall also support all pipe in the Packaged System higher than four feet from the floor or base level. The framework shall be primed and finish painted using the paint system described in this section.
e. Roof Mounted Lifting Lugs: If an enclosure is required and the package is to be split for shipping, then the wall and roof structural steel framework will be extended through the roof of the enclosure and incorporate lifting lugs so that the entire package can be lifted from the roof – no exceptions.
f. Interior Wall Panels: Interior walls panels shall be a minimum of 2" thick fabricated from a minimum of 22 ga. galvanized steel. The wall interior panel joints shall run horizontal (or 90 degrees to the exterior panels) to provide an acoustic break, and overlapped to be suitable for washing with a pressure washer or steam cleaned without risk of wetting the insulation. The wall panel shall be installed over top of the floor water dam such that any water run-off will drip onto the water-tight floor.
g. Insulation: Wall and roof shall be insulated with no less than 4" of 4.5 Lb/cu.ft density rigid or semi-rigid board type insulation equivalent to R-16. Floor insulation thickness will be no less than (i) the smallest structural steel member used to support the floor or (ii) 4", and shall have a minimum insulating valve of R-16. All insulation shall be rated non-combustible for continuous service at 1200F and shall be non-wicking with a moisture absorption rating of <1%.
h. Floor Drain Pan: Fabricate floor drain pans as shown on the drawings at a minimum of 12"x18"x2" deep from 18 ga. stainless steel seal welded and covered with 3/4"x1/8" floor grating. The use of drain holes in the floor is not acceptable. Drain pans shall be sloped at a minimum of 1% to a drain ¾" hole that shall be piped to the exterior of the unit and finished with a ¾" male NPT thread.
i. Roof Covering: The roof covering shall be standing seam panels.
j. Cooling Tower Structure Support & Access Mezzanine: The cooling tower structural steel support shall be sandblasted and painted. The access mezzanine will provide access to the cooling tower on three sides and shall be fabricated in accordance with OSHA guidelines. Provide one OSHA compliant ladder complete with safety cage.

3. The enclosure shall have the following structural ratings:
   a. A minimum snow/ sand load rating of 40 pounds per square foot.
   b. A minimum wind load rating of 150MPH.
4. The enclosure panels shall be acoustically designed with a sound Transmission Loss (TL) rating. The TL values must be rated across the eight octave bands. Sound pressure levels shall be predictable from any distance from the enclosure when sound power levels from the sound generating equipment are known. Calculations that support the sound data shall be provided on request.
5. All bases, enclosure floors and exteriors are to be factory painted. Enclosure paint shall have weather resistant finish that will withstand 500 hour exposure to the salt spray test specified in ASTM B 117. Paint shall be applied and allowed to dry for a sufficient amount of time before shipping. The paint shall be a non-isocyanate enamel that produces a durable, chemically resistant coating similar to urethane. The vehicle type shall be a cross-linked acrylic with an oxygenated and aromatic hydrocarbon solvent. All exterior surfaces shall be wiped down with thinners and prepared with a zero induction epoxy primer before applying paint. All interior surfaces shall be prepared with a high build epoxy primer before applying paint.

6. Ventilation louver and damper: Install stationary, storm proof louver and motorized damper for forced ventilation of the enclosure as shown on the drawings. Louvers shall be 6 inches deep with extruded aluminum blades and frame and 19 gauge galvanized ½" x ½" bird screen. Damper blades shall be 4 inches deep, thermally broken with high-density polyurethane CFC injected insulation. Air leakage through a 48" x 48" damper shall not exceed 10.5 CFM/SQFT against 4" w.g. differential static pressure @ standard air. Operating temperature range shall be -40° to +200°F. Supply an actuator to modulate the damper open or close.
7. Exhaust Fan: Install exhaust fans for forced ventilation of the enclosure as shown on the drawings sized in accordance with the requirements of ASHARAE Standard 15 for refrigerant evacuation and interlocked with the refrigerant monitoring/ alarm panel and the ventilation damper actuator. The fan shall be of bolted and welded construction utilizing corrosion resistant fasteners. Fan shall be enclosed in minimum 18 gauge galvanized steel wall housing with factory installed shutter and inlet guard.
8. Unit Heater: Install a 460V [575V] unit heater as shown on the drawings sized to maintain enclosure temperature at 70 degrees F with an outside air temperature of -10 degrees F. Interlock the ventilation damper actuator with the exhaust fan and the unit heater to a combination heat/ cool thermostat overridden only by the refrigerant monitoring/ alarm panel.

9. GAS FIRED BOILERS – Refer to Boiler Specification with Div 23 00 00.

10. PUMPS AND MOTORS
    a. Pumps shall be end suction type with cast iron housing, bronze impeller, shaft sleeve or stainless steel shaft, and internally flushed mechanical seal. Pump shall be flexibly coupled to the motor, and all couplings shall include an approved guard. Pump and motor will be mounted on structural steel base and free of distortion caused by flexing of the base or piping. Motors shall be of premium efficiency and open drip proof design. Both pumps and motors shall be installed with shims under so that they can be dropped down for alignment without milling. All pump selections shall be non-overloading over the entire curve.
    b. For variable speed applications the motor shall be selected to be compatible with the associated VFD. Refer to separate motor section. The flexible coupler between the motor and pump shall be EPDM for all variable speed applications.
    c. Double suction vertical split case base mounted style pumps are considered equal to the end suction style as long as they meet the criteria outlined above.
    d. Vertical In-Line style pumps are an acceptable equal up to and including 15HP motors.
    e. All pumps shall be furnished with a suction diffuser connected directly to the pump suction. Pumps shall be complete with a combination valve on the discharge. Refer to the manufacturer for minimum spool length needed between pump discharge and valve. The suction diffuser and combination valve must be from the same manufacturer as the pump. No exceptions.
    f. For pipe sizes greater then 12" a combination of separate check valve and isolation valve can be used in lieu of a triple duty valve, and a "Y" strainer can be used instead of a suction diffuser. A long radius elbow must be the minimum fitting required between the strainer and the pump suction.
    g. All pumps must be fitted with vibration isolation equipment consisting of spring isolators of the open type sized for 2" deflection, and double sphere flex connectors for both suction and discharge. Each pump shall be fitted individually with the vibration isolation described above, or as a package, where the base is mounted on spring isolators and the flex connectors are connected to the suction and discharge headers.
    h. Vibration isolation is not required for pipe mounted VIL style pumps.

11. AIR SEPARATOR AND MAKE-UP WATER SYSTEM
    a. Separators shall be manufactured in an ISO recognized facility. Each unit shall be factory tested per Hydraulic Institute standards at the factory of origin. Tangential type air separator shall have flanged or grooved inlet and outlet connections. The vessel shell diameter shall be three times the nominal inlet/outlet pipe diameter. The inlet and outlet connections must be of the same size. The unit will be designed, constructed and stamped for 125PSIG @350F in accordance with ASME Boiler and Pressure Vessel Code. Supply the separator with automatic air vent when used in an air elimination system, and connect the vent connection into the bottom of the compression tank for air control systems.
    b. A 3/4" make-up water system shall be connected to the outlet of the air separator. This system shall include pressure reducing valve, a Watts double check type backflow preventor, shut-off valves, Y-strainer, pressure gauge and manual by-pass.
12. EXPANSION TANKS
    a. Expansion tanks shall be manufactured in an ISO recognized facility. Each unit shall be factory tested per Hydraulic Institute standards at the factory of origin. For systems using air management systems, the expansion tank shall be a horizontal. The tank shall be designed, constructed, and stamped for 150PSI @ 650F in accordance with ASME Boiler and Pressure Vessel Code. The tank must be supplied with an airtrol fitting to be installed in bottom of the tank, and piped to the vent connect on the air separator.
    b. For air elimination systems, the expansion tank shall be a pressurized horizontal or vertical tank. The tank shall utilize either a bladder, or diaphragm to separate the air from the system water. Diaphragm and bladder tanks shall be factory charged with a .302-32 charging valve connection. The tank shall be designed, constructed, and stamped for 150PSI @ 650F in accordance with ASME Boiler and Pressure Vessel Code
13. VALVES, GAUGES AND PIPING ACCESSORIES
    a. Valves shall meet the material, fabrication and operating requirements of ASME B31.1. All valves shall be located such that the removal of their bonnets is possible. All flanged valves in horizontal lines with the valve stem in the horizontal position shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be of threaded or flanged type. All bronze and iron body gate and globe valves shall be the product of one manufacturer. Manufacturers of other types may not be mixed, i.e., all butterfly valves shall be of one manufacturer, all ball valves shall be of one manufacturer, etc. No yellow brass valves will be allowed. Wafer style valves (except check valves) are not allowed.
    b. Butterfly valves shall be constructed with a ductile iron lug body, EPDM seat, aluminum bronze disc, 410 stainless steel shaft and polyacetal stem bearing. Valves 6" and smaller shall be provided with lever operators and valves 8" and larger shall be provided with hand wheel and gear operator.
    c. Ball valves shall be full port type, cast bronze body and cap, brass stem with double O-ring stem seals, forged brass ball and PTFE seat. Stem extensions shall be furnished for use on all ball valves to be insulated.
    d. Check valves 2" and smaller shall be Y-pattern swing type, bronze body to ASTM B62 with forged brass cap and cast bronze disc. Check valves 2½" and larger shall be iron body, bronze disc and seat or non-slam lug or wafer type with stainless pins and springs and bronze plate.

e. Strainers 2" and smaller shall be constructed for 250 psig operating pressure at 406 degrees F and shall have a cast iron threaded body and 20 mesh Type 304 stainless steel screen. Strainers larger than 2" shall be constructed for 125 psig @ 150 degrees F and shall have a cast iron flanged body and a 3/64" perforated Type 304 stainless steel screen up to 3" and a 1/8" perforated Type 304 stainless steel screen on 4" and larger. Strainers 2" and smaller shall have straight thread and gasketed caps and plugged blow-off connections. Strainers larger than 2" shall include drain connections complete with ball valve, cap and chain.

f. Install thermometers so they can be easily read from floor level. If this cannot be accomplished, install remote reading units. Thermometers are to be installed in thermowells so that they can be replaced without draining the system. Thermometers shall have a 9" scale, cast aluminum case and adjustable angle stem.

g. Use one pressure gauge for each pump/ strainer assembly with connections upstream of the strainer, between the strainer and pump and on the discharge of the pump, all isolated with shut off valves.

h. Where three or more pumps share the same discharge or suction header install pressure gauges on a common gauge panel mounted next to the pump assembly. A manifold valve shall be used for each common pressure gauge allowing a manual selection of suction or discharge indication of individual pumps and headers. All sensing lines shall be stainless steel tubing and installed in aligning standoffs. Pressure gauges shall be liquid filled, 4" diameter, accurate to 1.5%.

14. PIPE AND PIPE SUPPORT

a. All pipe used in the Packaged System shall be fabricated in accordance with this specification. The use of grooved mechanical connections is not acceptable.

b. Unless otherwise indicated hot water and steam piping shall be Schedule 40 for pipe smaller than 12" and standard weight for pipe 12" and larger. All pipe shall conform to Standard ASTM Designation A53 grade A or B. All weld fittings shall conform to ASME/ ANSI B16.9, latest addition. All condensate and threaded pipe shall be Schedule 80 conforming to Standard ASTM Designation A53B.

c. Pipe welding shall be in accordance with ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessel Code, Section IX. Ensure complete penetration of deposited metal with base metal. Manufacturer shall provide filler metal suitable for use with basemetal. Keep inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process employing a shielded metallic arc process (SMAW) or gas metal arc welding process (GMAW/ MIG). Inside of pipe shall be free of excessive reinforcement. The use of backing plates is not acceptable. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during the welding operation.

d. In no cases shall Schedule 40 or standard weight pipe be welded with less than three passes including one stringer/ root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/ root, two filler and one lacer/ cap.

e. Each weld shall be uniform in width and size throughout its full length. In addition, the cover pass (final weld layer) shall be free of coarse ripples, grooves, overlaps, abrupt ridges and valleys/ under cut. The surface smoothness of the finished weld shall be suitable for the proper interpretation of non-destructive examination of the weld.

f. Each weld layer or pass shall be visually free of slag, inclusions, cracks, porosity and lack of fusion. Grinding to meet this criteria and elimination of defects and surface preparation of welds shall be done in a manner as not to gouge, groove or reduce the adjacent base material thickness below the minimum required.

g. All butt welds shall be full penetration with uniform crown, with reinforcement blending smoothly into the base material. Concavity on the root side of a single welded circumferential butt weld is permitted with the resulting thickness of the weld at least equal to the thickness of the thinner member of the sections being joined.
h. Socket welds shall have a gap of approximately 1/16" minimum to 1/8" maximum between the bottom of the socket and the end of the pipe prior to welding.
i. Visually inspect all welds for compliance with this section. Welds found to be lacking penetration, or containing excessive porosity or cracks must be removed and replaced with an original quality weld as specified herein.
j. All screw joints shall be made with tapered threads, properly cut. Joints shall be made with Teflon or dope applied to the pipe threads only and not to fittings. All threaded fittings shall conform to ASTM B16.3.
k. Copper pipe shall be fabricated of Type L conforming to ASTM specifications for copper water tube. Copper pipe shall only be joined using non-lead-solder such as 95-5 silver or antimony solder (95 percent tin and 5 percent silver or antimony).
l. All pipe shall be painted with a machine enamel in the Manufacturer's standard colour prior to assembly.
m. All piping for the Packaged System shall be sized for a maximum head loss of 4 feet W.C. per 100 feet equivalent pipe length. Piping shall be supported independently of connections to equipment. If an enclosure is used all pipe higher than four feet from the floor or base level must be supported from the roof framework to provide clear access to equipment. The only exception is where pipe is supported from a vibration isolation base as part of a pump assembly.
n. Piping shall be installed to facilitate drainage and/or condensate management. Install drain valves at low points in piping, at equipment and at section isolating valves. Install air vents at high points in each piping system.
o. Pipe supports shall be Behringer Pipe Clamps to support pipe under all conditions of operation and prevent excessive stresses and vibration from being introduced into pipe work or connected equipment. Oversized U-bolts are acceptable on pipe sizes over 10" but must be complete with spacers to allow for 2" insulation installed on site. Condenser water lines and gas lines may be supported using U bolts without insulation spacers for all line sizes.
p. Shop fabricate equipment supports not provided by equipment manufacturer from structural grade steel. Provide removable angle iron blocking and bracing to prevent movement of pipe work and equipment during shipping.

15. VIBRATION ISOLATION
a. An integral all welded steel vibration isolation base mounted on spring isolators shall be provided for the pumps and motors.
b. Provide open spring mounts with iso stiff springs, sound deadening pads and leveling bolts. Spring deflection shall be 2.
c. Flexible pipe connectors shall be designed for 125 psig service, or as appropriate for the static head plus system head, and 200 degrees F. The flexible connector shall be constructed of rubber or tetrafluoroethylene resin. The flexible section shall be suitable for intended service with end connections to match connecting piping. The use of reducing flexible connectors is not allowed. Connectors shall be flanged and equipped with limit bolts, rods or cable to restrict maximum travel.

16. ELECTRICAL FABRICATION
a. All Electrical fabrication work shall be in compliance with N.E.C. and C.E.C
b. All service, feeder, branch or control circuit conductors shall be housed in Electrical Metallic Tubing
c. All conductors used shall have a minimum temperature rating of 90 degree C
d. Separate EMT conduit is used to house power , control and signal conductors

17. MOTOR CONTROL CENTERS
    a. General
        1) The motor control center shall be constructed to meet or exceed the requirements within NEMA ICS3-322, UL845, CSA22.2, and IEC 439-1 for motor control centers. The motor control center shall be designed, manufactured, and tested in facilities registered to ISO9001 quality standards.
    b. Ratings
        1) Voltage - Unless shown differently on the drawings, the MCC shall be rated for a 480V system.
        2) Short Circuit Withstand Rating – Unless shown differently on the drawings, the MCC shall be rated for a fault current of 65,000A at 460VAC
    c. Structure
        1) The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections and to permit the interchanging of units. The overall length of the MCC shall not exceed the dimensions shown on the drawings.
        2) Vertical sections shall be rigid, free-standing structures.
        3) Vertical sections shall have internal mounting angles running continuously within the shipping block.
        4) Vertical sections shall be 90 inches high, 20 inches deep and 20 inches wide except where larger dimensions are required.
18. GLYCOL FILL SYSTEM
    a. The autofill glycol unit shall be complete with an expansion tank to control and provide expansion and maintain the glycol system pressure by providing glycol make-up upon a drop in system pressure.
    b. The glycol auto-fill unit is to be provided with the following standard features:
        1) The unit must monitor and maintain the minimum system pressure at all times.
        2) Low mixture cut-out level switches shall monitor the status of the mixing tank.
        3) Level switches shall be 48 volt maximum to ensure intrinsic electrical safety.
        4) Pump suction isolation valve.
        5) Pump suction strainer.
        6) Single phase power connection.
        7) 45 PSI fill pressure.
19. LOW VOLTAGE PANELBOARD DISTRIBUTION
    a. General
        1) The panel board shall be constructed to meet or exceed the requirements within UL 67 panel boards, cabinets and boxes UL 50 NEC, CSA , NEMA Standard PB1 . The panel board shall be designed, manufactured, and tested in facilities registered to ISO9001 quality standards.
        2) All circuit breakers within the panel board shall be UL listed under UL 489.
20. VARIABLE FREQUENCY DRIVES
    a. General
        1) A Variable Frequency Drive shall be furnished where pump or fan speed regulation is required. The VFD can be housed within a MCC enclosure or wall mounted as required. The drive shall be listed UL, ETL and/or CSA.
        2) Where applicable a VFD shall include manual bypass control
        3) Standard Displays
            a) Output Frequency (HZ)
            b) Set-Point Frequency (HZ)
            c) Motor Current (Amperes)
            d) DC Bus Voltage (VDC)

4) Control Signal Interface
   a) 0 to 10 VDC
   b) 0-20 or 4-20ma
   c) Fixed frequencies using digital inputs
   d) RS-485
   e) Ethernet IP
5) Output Signal Interface: A minimum of 1 4-20ma output signal which can be programmed to any of the following.
   a) Output Frequency (HZ)
   b) Output Current (Amperes)
   c) Motor Torque (Percent)
   d) Motor Speed (RPM)
6) Remote Indication Interface : minimum of 2 dry contact relays outputs for remote indication of the following
   a) Motor Enabled
   b) Motor Running
   c) Fault or warning indication

21. AUTOMATED CONTROL SYSTEM
   a. Automated process control shall be a PLC based system with the functional equivalent of an Allen Bradley Compact Logix processor.
   b. An operator interface display touch screen shall be provided to allow process monitoring , alarm display , process trending and setpoint edits. The minimum size of the touch screen shall be 15”
   c. The control system shall have the capability of remote access to allow troubleshooting or system updates.
   d. The control system shall have the ability to interface with BAS as required
   e. The controller software has the ability to automatically diagnose and report process hardware failures and make equipment substitutions, where applicable to maintain the process.

2.10 HIGH EFFICIENCY, GAS-FIRED CONDENSING BOILER (Refer to section 018100 Commissioning for additional contract requirements)

A. General: Provide condensing gas-fired boilers, suitable for firing with natural gas utilizing a forced draft combustion system. Each boiler shall display ASME (H) stamp, certifying unit meets the ASME requirements for low pressure hot water boilers. Boiler(s) shall be suitable to operate under any return water temperature, any boiler water flow rate and without any restrictions on temperature rise through the boiler vessel. Boiler(s) shall be able to operate at efficiencies up to 98% at suitably low return water temperatures. Boiler(s) shall have an internal water baffle plate separating return water between second and third flue passages for maximum efficiency. Boiler(s) shall be fully serviceable from the front by means of a reversible swing burner door and removable access cover for easy cleaning and inspection. Each boiler to include neutralization tank or condensate trap for boiler condensate.

B. Heat Exchanger: The boiler(s) shall have a full three pass fire tube design to allow complete combustion of the fuel in the main combustion chamber. All flue side surfaces, including the main combustion chamber, second and third flue passages shall be constructed of 316 stainless steel designed to maximize the condensate formation. All flue passages shall be fully water-backed to minimize thermal stresses on the boiler vessel. The condensing secondary and tertiary fire tube flue passages shall be fabricated from 316 stainless steel with a reduced cross section in the direction of flue products flow to maintain a near constant velocity of combustion products and to enhance micro turbulences for maximum heat transfer. The pressure vessel shall be carbon steel with welded heads and tube connections, and separation plate separating low- and high-temperature returns. Boiler designs utilizing cast iron or aluminum heat exchangers are not acceptable.

C. Casing: The jacket shall be sheet metal, with snap-in or interlocking closures with electrostatic powder-coated protective finish. Unit shall be insulated with minimum 4-inch- thick, glass fiber insulation surrounding the heat exchanger.

D. Control Options: The control package must be factory tested to ensure proper operation. The control package shall include the following hardware as standard equipment: boiler control c/w boiler temperature sensor, capillary for adjustable high limit (AHL), capillary for fixed manual reset temperature high limit (FHL), supply and outdoor air sensors for reset control of the heating system. The control shall have night setback capability, display and easy adjustment of the heating schedule. Provide all code required boiler safety controls, including burner shut-off switch, AHJ, and FHL controls. Provisions shall be made for control of multiple boiler installation with full modulation burners and an adjustable responsiveness to outdoor temperature variations. Burners shall be provided with Electric ignition, standing pilots lights are unacceptable. Provide BACNET communication card for seamless communication with DDC system.

E. Warranty: Manufacturer's agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period which shall include:
1. Leakage and Materials: 5 years from date of Substantial Completion.
2. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for [5] years from date of Substantial Completion.
3. Refer to general conditions for additional warranty requirements that may apply.

F. Manufacturer: Subject to compliance with requirements, provide boilers of one of the following:
1. Lochinvar
2. Buderus
3. Viessman
4. Or Equal.

2.11 PUMPS (P) (Refer to section 018100 Commissioning for additional contract requirements)

A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

B. Inline Circulator Pumps:
1. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled.
2. Type: Horizontal mount, vertical split case, oil-lubricated, designed for 125 psi working pressure, and 225° F. (107° C) continuous water temperature.
3. Body: Cast-iron, with suction and discharge gage tappings.

4. Shaft: Hardened alloy steel.
5. Bearings: Oil-lubricated bronze journal bearings.
6. Seal: Mechanical, with carbon seal ring and ceramic seat.
7. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil-lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
8. Couplings: Self-aligning, flexible coupling.
9. Impeller: Enclosed type hydraulically and dynamically balanced, and keyed to shaft.
10. Manufacturer: Subject to compliance with requirements, provide in-line circulator pumps of one of the following:
    a. Bell & Gosset ITT; Fluid Handling Div.
    b. Armstrong Pumps, Inc.
    c. Taco, Inc.
    d. Or Equal

C. Frame-Mounted End Suction Pumps:
1. General: Provide frame-mounted end suction pumps where indicated, and of capacities and having characteristics as scheduled.
2. Type: Horizontal mount, single stage, vertical split case, flexible coupling, base mounted, designed for 175 psi working pressure.
3. Casing: Cast iron, 125 psi ANSI flanges, tappings for gage and drain connections.
4. Shaft: Steel with replaceable shaft sleeve.
5. Bearing: Regreasable ball bearings.
6. Seal: Mechanical, with carbon seal ring and ceramic seat.
7. Motor: Open, dripproof, regreasable ball bearings.
8. Impeller: Enclosed type, hydraulically and dynamically balanced keyed to shaft and secured with locking screw.
9. Baseplate: Structural steel with welded cross members, and open grouting area.
10. Coupling: Flexible, capable of absorbing torsional vibration, equipped with coupling guard.
11. Manufacturer: Subject to compliance with requirements, provide frame-mounted end suction pumps of one of the following:
    a. Bell & Gosset ITT; Fluid Handling Div.
    b. Armstrong Pumps, Inc.
    c. TACO
    d. Or Equal.

2.12 ROOFTOP UNITS (RTU) (Refer to section 018100 Commissioning for additional contract requirements)

A. Manufacturers
1. Subject to compliance with requirements specified here within provide rooftop units as manufactured by Innovent, Valent, Seasons 4, MAFNA, Greenheck, or approved equal by the engineer.
2. Alternate pricing based on pre-approved manufacturers will be considered if the following performance requirements and construction techniques are adhered to in all respects. Any substitutions shall be approved by the Architect/Engineer/Owner in writing ten (10) days prior to bid.

B. General
1. Rooftop air handling units shall be of the 100% outside dedicated outside air design (DOAS). Units shall be of the configuration, capacity, and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.
2. The unit shall be constructed for outdoor installation. Outdoor unit to be provided with weatherproofing outside air intake hood and shutoff dampers for supply and exhaust.

C. General Description
1. Furnish as shown on plans. Unit performance and electrical characteristics shall be per the job schedule.
2. Provide the unit with the following sections at a minimum:
   a. Return fan/economizer section
   b. Filter sections
   c. Supply fan section
   d. Gas-fired heating section
   e. Access sections
   f. Cooling coil section
   g. Diffuser (as required)
   h. Discharge/intake plenums
   i. Condensing unit section
3. The complete unit shall be ETL listed. The burner and gas train for the unit furnace shall be IRI/FIA approved.
4. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Units shall be of a modular design with factory installed access sections available to provide maximum design flexibility.
5. Unit is to be shipped factory assembled in one complete section, when possible. Each unit shall be either completely factory assembled and shipped in one piece or split at the condensing section and/or split between the supply fan section and the heat section. Packaged units shall be shipped fully charged with Refrigerant R410A. Units split between the evaporator and the condensing sections are shipped with a nitrogen holding charge only. Unit manufacturer and contractor shall coordinate ship split and field installation, refrigerant charging, and all unit field inter-connection requirements.
6. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include final balancing of the supply and return fan assemblies, a refrigeration circuit run test, a unit control system operations checkout (for controls provided with unit), test and adjustment of the gas furnace, a unit refrigerant leak test and a final unit inspection.
7. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.
8. The Rooftop unit shall be designed, manufactured, and independently tested, rated, and certified to meet the seismic standards of the 2009 International Building Code and ASCE 7-06.
   a. Certificates of Compliance shall be provided with the submittal and include the manufacturer's identification, designation of certified characteristics, and the Independent Certifying Agency's name and report identification.
   b. Clear installation instructions shall be provided including all accessory components.
9. Performance: All scheduled capacities and face areas are minimum accepted values. All scheduled amps, kW, and hp are maximum accepted values that allow scheduled capacity to be met.

10. Warranty: The manufacturer shall provide 12-month parts only warranty. The manufacturer will provide extended 5 year, parts only, warranty on the compressor. Defective parts shall be repaired or replaced during the warranty period at no charge. The warranty period shall commence upon project completion date.

D. Cabinet, Casing and Frame
1. Provide double-wall construction for all side wall access doors and floor areas shall be provided with 17 gauge exterior and 22-gauge interior, solid G60 galvanized steel construction. Inner liners shall protect insulation during service and maintenance. Unit cabinet shall be designed to operate at total static pressures up to 6.5 inches w.g.
2. Insulation on ceiling and end panels shall be secured with adhesive and mechanical fasteners. Heavy gauge solid galvanized steel liners shall be provided throughout, allowing no exposed insulation within the air stream.
3. All cabinet insulation, except floor panels, shall be a nominal 2" thick, 1½-lb. density, R6.5, glass fiber. A combination of solid and perforated galvanized steel liners shall be provided throughout. Perforated liners to be used in the supply and return air plenums to provide improved sound attenuation. Insulation under perforated liners shall be coated with hospital grade liner rated in accordance with standard ASTM C-1071.
4. All floor panels shall include double wall construction and include a nominal 2” thick, 3 lb. density, R4.2 per inch glass fiber insulation.
5. Exterior surfaces shall be constructed of pre-painted galvanized steel for aesthetics and long term durability. Paint finish to include a base primer with a high quality, polyester resin topcoat of a neutral beige color. Finished surface shall withstand a minimum 750-hour salt spray test in accordance with ASTM B117 standard for salt spray resistance. Service doors shall be provided on both sides of each section in order to provide user access to all unit components.
6. Service doors shall be constructed of heavy gauge galvanized steel with a gauge, galvanized steel interior liner. All service doors shall be mounted on multiple, stainless steel hinges and shall be secured by a latch system that is operated by a single, flush-mounted handle. The latch system shall feature a staggered engagement for ease of operation. Removable panels, or doors secured by multiple, mechanical fasteners are not acceptable.
7. The unit base frame shall be constructed of 13-gauge pre-painted galvanized steel. The unit base shall overhang the roof curb for positive water runoff and shall have a formed recess that seats on the roof curb gasket to provide a positive, weather-tight seal. Lifting brackets shall be provided on the unit base with lifting holes to accept cable or chain hooks.

E. Supply and Return Fans
1. All fan assemblies shall be statically and dynamically balanced at the factory, including a final trim balance, prior to shipment. All fan assemblies shall employ solid steel fan shafts. Heavy-duty pillow block type, self-aligning, grease-lubricated ball bearings shall be used. Bearings shall be sized to provide an L-50 life at 200,000 hours. The entire fan assembly shall be isolated from the fan bulkhead and mounted on spring isolators with seismic restraints.
2. Adjustable pitch V-belt drives with matching belts shall be provided. V-belt drives shall be selected at manufacturer’s standard service factor of 1.5 times fan brake horsepower.
3. Fan motors shall be heavy-duty 1800 rpm open drip-proof (ODP) type with grease-lubricated ball bearings. Motors shall be premium efficiency and meet applicable EPACT/NEMA requirements. Motors shall be mounted on an adjustable base that provides for proper alignment and belt tension adjustment.

4. Airfoil type supply and return (exhaust) fans - supply fans shall be double width, double inlet (DWDI) airfoil centrifugal fan. All fans shall be mounted using shafts and hubs with mating keyways. Fans shall be Class II type and fabricated from heavy-gauge aluminum. Fan blades shall be continuously welded to the back plate and end rim. The supply air fan and return air fan sections shall be provided with an expanded metal belt guard.

F. Variable Air Volume Control
1. Provide variable frequency drive for the supply and return air fan. Two independent drives, one per fan, shall be provided. Each drive shall be factory installed downstream of the filters in a manner that the drive(s) are directly cooled by the filtered, mixed air stream. Drives shall meet UL Standard 95-5V and the variable frequency drive manufacturer shall have specifically approved them for plenum duty application. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly complete with a single handle latch mechanism. Mounting arrangements that expose drives to high temperature, unfiltered ambient air is not acceptable.
2. The unit manufacturer shall install all power/control wiring. A manual bypass contactor arrangement shall be provided. The arrangement will allow fan operation at full design cfm, even if the drive has been removed for service. Line reactors shall be factory installed for each drive. Variable frequency drives shall be equipped with features as indicated in Division 26 00 00 Variable Frequency Drive specification requirements.
3. The supply air fan drive output shall be controlled by the factory installed main unit control system and drive status and operating speed shall be monitored and displayed at the main unit control panel. The supply and return/exhaust fan drive outputs shall be independently controlled in order to provide the control needed to maintain building pressure control. Supply and return/exhaust air fan drives that are slaved off of a common control output are not acceptable.
4. All drives shall be factory run tested prior to unit shipment.

G. Electrical
1. Unit wiring shall comply with NEC requirements and with all applicable UL standards. All electrical components shall be UL recognized where applicable. All wiring and electrical components provided with unit shall be numbered and color-coded and labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal board shall be provided for low voltage control wiring. Branch short circuit protection, 115-volt control circuit transformer and fuse, system switches, high temperature sensor, and a 115-volt receptacle with a separate electrical connection shall also be provided with unit.
2. Each compressor and condenser fan motor shall be furnished with contactors, current sensing manual motor and short circuit protection, and inherent thermal overload protection. Supply and return fan motors shall have Circuit breakers and built in overload protection with VFDs. Knockouts shall be provided in the bottom of the main control panels for field wiring entrance. All 115–600 voltage wire shall be protected from damage by raceways or conduit.
3. A factory installed and wired marine service light, with switch and receptacle, shall be provided in the supply air and return/exhaust fan section. The separate, main unit service receptacle electrical circuit shall also power the light circuit.
4. A factory installed and wired 115 volt power supply shall be provided for the GFI receptacle. The power supply shall be wired to the line side of the disconnect so the receptacle is powered when the main unit disconnect is off. This option shall include a weather proof transformer and disconnect for the 115 volt GFI. The 115 volt GFI electrical circuit shall complete with primary fused short circuit protection.
5. Phase failure and under voltage protection on three-phase motors shall be provided to prevent damage from single phasing, phase reversal, and low voltage conditions.

6. Ground fault protection shall be provided to protect against arcing ground faults.
7. Smoke detectors shall be field installed as shown on the drawings. Smoke detectors shall be furnished and wired to the building Fire Alarm system by the Division 260000 Contractor and installed by the HVAC Contractor.
8. Disconnect switches shall be provided by Division 260000.

H. Cooling Sections
1. The cooling coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with factory piped cooling coil and sloped stainless steel drain pan. Hinged access doors on both sides of the section shall provide convenient access to the cooling coil and drain pan for inspection and cleaning.
2. Submittals must demonstrate that scheduled unit leaving air temperature (LAT) is met, that fan and motor heat temperature rise (TR) have been considered, and scheduled entering air temperature (EAT) equals mixed air temperature (MAT). Draw-through cooling—Scheduled EAT equals cooling coil EAT and scheduled unit LAT equals cooling coil LAT plus TR.
3. Direct expansion (DX) cooling coils shall be fabricated of seamless 1/2" diameter high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a maximum of 12 fins per inch. All units shall have two independent refrigerant circuits and shall use an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.
4. A stainless steel, positively sloped drain pan shall be provided with the cooling coil. The drain pan shall extend beyond the leaving side of the coil and underneath the cooling coil connections. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall be connected to a threaded drain connection extending through the unit base. Units with stacked cooling coils shall be provided with a secondary drain pan piped to the primary drain pan. Drain pan connections shall be field traped per manufacturer's instructions and piped to the nearest roof drain to prevent ponding on the roof.

I. Gas Heating Section
1. A natural gas fired furnace shall be installed in the unit heat section. The heat exchanger shall include a type 321 stainless steel cylindrical primary combustion chamber, a type 321 stainless steel header, type 321 stainless steel secondary tubes and type 321stainless steel turbulators. Carbon and aluminized steel heat exchanger surfaces are not acceptable.
2. The heat exchanger shall have a condensate drain.
3. Clean out of the primary heat exchanger and secondary tubes shall be accomplished without removing casing panels or passing soot through the supply air passages.
4. The furnace section shall be positioned downstream of the supply air fan.
5. The furnace will be supplied with a modulating forced draft burner. The burner shall be controlled for low fire start. The burner furnace shall be supplied with a McQuay SuperMod or equal forced draft burner capable of continuous modulation between 5% and 100% of rated capacity, without steps. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low prepurge cycle, and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses.
6. The burner shall be specifically designed to burn natural gas and shall include a microprocessor based flame safeguard control, combustion air proving switch, prepurge timer and spark ignition. The gas train shall include redundant gas valves, regulators compatible with project gas pressure requirements, shutoff cock, pilot gas valve, pilot pressure regulator, and pilot cock. The burner shall be rated for operation and full modulation capability at inlet gas pressures down to 7.0.in. W.C. The gas burner shall be controlled by the factory installed main unit control system.

7. The burner shall have electric ignition, standing pilot lights are unacceptable.
8. The burner shall be fired, tested and adjusted at the factory. Final adjustments shall be made in the field at initial startup by a qualified service technician to verify that installation and operation of the burner is according to specifications.
9. Flue collector construction shall consist of type 409 stainless steel. Where applicable by MA CHPS or code requirements, flue discharge with weather cap shall discharge a minimum of 2 ft. higher than outdoor air intakes located closer than 25 feet from flue discharge.

J. Filters
1. Unit shall be provided with filter sections. The filter sections shall be supplied complete with the filter rack as an integral part of the unit. The draw-through filter section shall be provided with panel and cartridge filters.
2. Filters shall be frame mounted and shall slide into galvanized steel racks contained within the unit. Filters shall be installed in an angular arrangement to maximize filter area and minimize filter face velocity. Filters shall be accessible from both sides of the filter section.
3. 4" deep MERV 13, efficient, UL Std. 900, Class 1, AmericanAirFilter cartridge filters shall be provided. 2" panel, 30% efficient pre-filters shall be included. Cartridge filters shall consist of filter media permanently attached to a metal frame and shall slide into a gasketed, extruded aluminum rack contained within the unit. The filter rack shall have secondary gasketed, hinged end panels to insure proper sealing. Filters shall be accessible from both sides of the filter section. Filter set quantities shall be provide as indicated in Part III.

K. Outdoor / Return Air Section
1. Return Air Plenum- Unit shall be provided with a return air plenum capable of for handling 100% re-circulated air. The 100% return air plenum shall allow return air to enter from the bottom of the unit. McQuay UltraSeal or equal low leak dampers shall be provided. Damper blades shall be fully gasketed and side sealed and arranged vertically in the hood. Damper leakage shall be less than 0.2% at 1.5 inches static pressure differential. Leakage rate to be tested in accordance with AMCA Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers. Control of the dampers shall be from a field installed modulating actuator provided by the ATC contractor.

L. Energy Recovery Section and Components (As Scheduled)
1. Provide unit shall be provided with a modulating outdoor air economizer section with an ARI certified energy recovery wheel. The economizer section shall include outdoor, return and return exhaust air dampers. Bypass dampers shall be included that automatically bypass outdoor air around the wheel during economizer operation. Actuators shall be provided by the ATC contactor.
2. Outdoor air shall enter at the back of the section through a factory-installed hood capable of handling 100% outdoor air. The outdoor air hood shall be factory installed and constructed from galvanized steel finished with the same prepainted finish as the main unit. The hood shall include a bird screen to prevent infiltration of foreign material and a rain lip to drain water away from the entering air stream. Return air shall enter through the bottom of the unit.
3. The entire section shall be double-wall construction.

4. The enthalpy wheel shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated, bonded, or synthesized onto the media are not acceptable due to delamination or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from laboratory chemicals present in pharmaceutical, hospital, etc. environments as well as attack from external outdoor air conditions. Coated aluminum is not acceptable. Face flatness of the wheel shall be maximized (+/–0.032 in.) in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling, internal bypass or leakage, and performance degradation. The media shall be in accordance with NFPA or UL guidelines. The desiccant material shall be a molecular sieve, specifically a 4A or smaller molecular sieve to minimize cross contamination. The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment. The wheel seals shall be brush seals, neoprene bulb seals, or equivalent. Seals should be easily adjustable. Cassettes shall be fabricated of heavy duty reinforced galvanized steel. Cassettes shall have a built-in adjustable purge section minimizing cross contamination of supply air. Bearings shall be in board, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged bearings.
5. Drive systems shall consist of fractional horsepower A.C.drive motors with multilink drive belts. The wheel shall be tested in accordance with NFPA or UL guidelines and shall be UL recognized or equivalent.
6. The wheel capacity, air pressure drop, and efficiency shall be ARI certified by ARI and its testing agencies. Alternative independent performance testing must be pre-approved to be accepted.
7. Wheel shall be provided with variable speed control for frost protection.
8. The wheel recovers energy from the factory-supplied return exhaust section and includes an airfoil fan and motor in accordance with construction already specified. Gravity relief dampers and fold-out exhaust hood shall be provided.
9. All necessary exhaust fan motors, branch short circuit protection, and wiring shall be provided.
10. Two-inch, 30% pleated filters shall be provided in both air inlets to protect the wheel from dust and dirt in both the outdoor and return/exhaust air paths. Dampers to be McQuay UltraSeal or equal, low-leak type, and shall be provided on outdoor or return dampers. Damper blades shall be fully gasketed and side sealed and arranged horizontally in the hood. Damper leakage shall be less than 0.2% at 1.5 inches static pressure differential. Leakage rate to be tested in accordance with AMC Standard 500. Damper blades shall be operated from multiple sets of linkages mounted on the leaving face of the dampers.

M. Access Sections - Unit shall be provided with factory installed access sections located as shown/indicated on the drawings. Access sections shall have hinged access doors on both sides of the section and shall have the same construction features as the rest of the unit.

N. Discharge and Return Plenum - A supply air discharge and return plenum shall be provided. The plenum section shall be lined with a perforated acoustic liner (rated per ASTM C1071 Standards) to enhance sound attenuation. The plenum section shall have a bottom discharge opening. Isolation dampers shall be provided in the bottom return air opening and bottom supply air openings. Actuators shall be provided by the ATC contractor to close the dampers when the fans are not running.

O. Condensing Unit
   1. The condensing section shall be open on the sides and bottom to provide access and to allow airflow through the coils. Condenser coils shall be multi-row and fabricated from cast aluminum micro-channel coils. Each condenser coil shall be factory leak tested with high-pressure air under water. Coils are to be recessed so that the cabinet provides built in hail protection.
   2. Condenser fans shall be direct drive, propeller type designed for low tip speed and vertical air discharge. Condenser fan rpm shall be 1140 rpm maximum. Fan blades shall be constructed of steel and riveted to a steel center hub. Condenser fan motors shall be heavy-duty, inherently protected, three-phase, non-reversing type with permanently lubricated ball bearing and integral rain shield.
   3. Each circuit shall have fan cycling of at least one condenser fan to maintain positive head pressure. An ambient thermostat shall prevent the refrigeration system from operating below 45º F.
   4. Liquid tight conduit shall be provided on exposed condensing section wiring.
   5. Compressors- Each unit shall have multiple, heavy-duty Copeland scroll compressors. Each compressor shall be complete with crankcase heater, sight-glass, anti-slug protection, current sensing and motor temperature sensing, motor overload protection and a time delay to prevent short cycling and simultaneous starting of compressors following a power failure. Compressors shall be isolated with resilient rubber isolators to decrease noise transmission.
   6. Refrigeration Controls - Each unit shall have two independent refrigeration circuits. Each circuit shall be complete with low pressure control, filter-drier, liquid moisture indicator/sight-glass, solenoid, thermal expansion valve, liquid line shutoff valve with charging port, discharge line shutoff valve, a manual reset high pressure safety switch and high pressure relief device. The thermal expansion valve shall be capable of modulation from 100% to 25% of its rated capacity. Sightglasses shall be accessible for viewing without disrupting unit operation. Each circuit shall be dehydrated and leak tested.
   7. Capacity Control- Refrigeration capacity control shall be accomplished by staging of the unit's multiple compressors. To maintain desired temperature control, the unit shall have a minimum four steps of capacity control.
   8. All compressor capacity control staging shall be controlled by the factory installed main unit control system.
   9. Hot gas bypass control shall be factory installed on one refrigerant circuits. Hot gas bypass control shall include a modulating hot gas bypass control valve, associated piping and be automatically operated by the units microprocessor control.
   10. A vandal protection screen shall be provided on the condensing section. It will be constructed from PVC coated, 12-gauge steel wire.
   11. Modulating hot gas reheat shall be provided on the lead circuit complete with modulating valves, micro-channel refrigerant reheat coil, and dehumidification control. Controls shall maintain ± .5°F control of the reheat coil leaving air temperature.

P. Roof Curb – Refer to Section 23 05 48

Q. Controls
   1. General – Automatic Temperature controls for Rooftop unit shall be DDC (direct digital control type). All sensors, actuators, controls not indicated in the specifications above shall be provided by the ATC/DDC controls contractor.
   2. Unit manufacturer shall provide terminal strips for all control devices not furnished by ATC contractor. Including but not limited to modulating gas valve, compressor capacity controls, and hot gas subcool and reheat control.
   3. Refer to Specification Section 23 00 00 ATC control specification requirements and Control Diagram Drawings for Rooftop unit control requirements and expanded sequence of operation and required points list.

4. HVAC and ATC Contractors shall coordinate with unit manufacturer to ensure all sequence of operation and control points are achieved with the BMS to complete the specified sequence of operation and points lists.

2.13 ROOFTOP H & V UNITS GAS FIRED (HV) (Refer to section 018100 Commissioning for additional contract requirements)

A. General: Rooftop unit shall be factory assembled with single pipe gas connection, piped, wired, and test fired, designed for roof or slab installation and consisting of Furnace Section, Fan Section, Downflow Supply Plenum, Bottom Return/100% Outside Air Section as defined on the in the drawings and in the schedule. Capacities and electrical characteristics shall be as scheduled.

B. Casing: Manufacturer's standard casing construction, having corrosion protection coating and exterior finish. Casings shall have removable panels or access doors for inspection and service, a minimum of 1" thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.

C. Roof Curbs: Refer to section 23 05 48.

D. Supply Fans:
1. Fans must be dynamically balanced for quiet operation and shall contain belt-driven centrifugal fans with adjustable pitch motor sheaves. After balancing this supplier to provide fixed sheave of proper pitch to meet design conditions.

E. Burners:
1. Burners shall be die-formed with stamped porting and stainless steel port protectors to prevent scale or foreign matter from obstructing the burner ports. Burner construction shall consist of:
   a. Type 409 stainless steel.
   b. Modulating Gas Valve, minimum 10 to 1 turndown.
   c. Electric ignition, standing pilots lights are unacceptable.
2. Burners must be individually removable for ease of cleaning and servicing. The entire burner assembly must be easily removable with a slide-out drawer design. The pilot must be accessible through a pilot access plate without removing the burner assembly.

F. Heat Exchanger:
1. Heat exchanger construction shall consist of 20 gauge type 321 stainless steel tubes, seam welded, and 20 gauge headers.

G. Venting System:
1. Flue collector construction shall consist of type 409 stainless steel.
2. Rooftop shall be provided with a power vent fan. Outside air for combustion and products of combustion shall have individual air inlet and discharge grilles located in the upper section of a split burner service panel.

H. Controls - Electric and Gas:
1. A factory installed control box or junction box shall be provided for all power connections. A 24 volt control transformer, high limit, and fan time delay relay must be provided. The fan time delay relay delays the fan start until the heat exchanger reaches a predetermined temperature. It also allows the fan to operate after burner shutdown to remove residual heat from the heat exchanger.

2. Rooftop units shall be provided with gas valves suitable for Class 2, maximum inlet pressure of 0.5 psi (14" W.C.) on natural gas. The 24 volt combination automatic gas valves must include a main operating valve, pilot safety shutoff, pressure regulator, manual main and pilot shutoff valve, and adjustable pilot valve. Gas valves shall be electronic 100% modulating. Ignition shall be at full fire (100% input) and modulate the gas input from 100 to 0% rated input. Gas valve shall be energized through a duct thermostat with an override room thermostat which shall cause the unit to go to full fire when the room temperature falls below the override room thermostat's set point. Refer to schedule for exact operating gas pressure.
3. A solid-state ignition control system shall be provided which ignites the pilot by spark during each cycle of operation. When pilot flame is proven, main burner valve shall open to allow gas flow to burners. Pilot and burners must be extinguished during the off cycle.
4. Provide gas inlet pressure proving switch.

I. Temperature Controls are to be furnished and installed by the ATC Contractor. Unit manufacturer shall provide terminal strips control devices not furnished by ATC contractor, including modulating gas valve. Refer to Specification Section 23 00 00 ATC control specification requirements and Control Diagram Drawings for Rooftop unit control requirements and expanded sequence of operation and required points list. HVAC and ATC Contractors shall coordinate with unit manufacturer to ensure all sequence of operation and control points are achieved with the BMS to complete the specified sequence of operation and points lists.

J. Filters: Unit to be furnished with 2” pleated supply air filters with MERV -13 efficiency. Filters quantities shall be provided as indicated in Part III.

K. Manufacturers: Subject to compliance with requirements, provide units of one of the following:
1. Greenheck
2. Sterling
3. Reznor
4. McQuay
5. Trane
6. Or Equal.

2.14 VARIABLE AIR VOLUME BOX (VAV)

A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.

B. Casings: Construct of die-cast aluminum or sheet metal of the following minimum thicknesses:

	Steel	Aluminum
1. Upstream Pressure Side:	24-ga.	0.032"
2. Downstream Pressure Side;	26-ga.	0.025"

3. Provide hanger brackets for attachment of supports.
4. Linings: Line inside surfaces of casings with hospital grade lining material meeting ASTM Standard C1071 to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1". Secure lining to prevent delamination, sagging or settling. Seal edges of lining to prevent fraying.
   a. Cover liner surfaces and edges with mylar, foil or perforated metal.
5. Leakage: Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 4% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 10% of specified air flow capacity.

C. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers, pressure independent that are calibrated in cfm, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper from minimum to maximum, in response to signal from thermostat.

D. Controls: Provide controls accurate to 1.5 degrees F(0.8 degrees C) and adjustable from 65 degrees F (22 degrees C) to 85 degrees F (29 degrees C).
1. ATC Contractor to provide and field install DDC controls, compatible with automatic temperature control system specified in other Division-15 sections. All testing and commissioning shall be completed in field.

E. Identification: Provide label on each unit indicating Unit Number, cfm range, cfm factory-setting, and calibration curve (if required).

F. Coils: Provide the following coils as indicated on Drawings and schedule:
1. Hot Water Heating Coils: Provide heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.

G. Manufacturer: Subject to compliance with requirements, provide variable air volume boxes of one of the following:
1. Price
2. Carnes Co.
3. Titus Products Div.
4. Or equal

2.15 KITCHEN GAS FIRED MAKE-UP AIR UNIT (MAU) (Refer to section 018100 Commissioning for additional contract requirements)

A. Gas Train and Controls: Indirect fired gas system shall have a draw through design, field adjustable burner baffles and Maxon type NP burner for optimal burning efficiency. Flame safeguard shall be Honeywell 7800 series with digital coded fault indicator capability. Fault indicator shall provide service history by storing codes for the last five faults. Safety shutoff valves shall be industrial duty and use 120 VAC control signals. Temperature control shall incorporate an electronic modulation control system.

B. Unit Casing and Frames: Unit shall be of internal frame type construction of galvanized steel. All frames and panels shall be G90 galvanized steel. Where top panels are joined there shall be a standing seam to insure positive weather protection. All metal-to-metal surfaces exposed to the weather shall be sealed, requiring no caulking at job site. All components shall be easily accessible through removable or hinged doors.

C. Insulation: Unit casing to be lined with 1 in. fiberglass insulation. Insulation in accordance with NFPA 90A and tested to meet UL 181 erosion requirements and secured to unit with waterproof adhesive and permanent mechanical fasteners.

D. Fan Section: Centrifugal fans shall be double width, double inlet. Fan and motor shall be mounted on a common base and shall be internally isolated. All blower wheels shall be statically and dynamically balanced. Ground and polished steel shafts shall be mounted in permanently lubricated ball bearings (up to size 118) or ball bearing pillow blocks (size 120 or larger). Bearings shall be selected for a minimum (size 120 or larger). Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged speeds.

E. Heat Exchanger: The heat exchanger shall be heavy-duty stainless steel with airfoil contoured die-formed tubes, individually removable aluminized steel burner with stainless steel ribbons and cross lighter, pilot assembly, and slide out burner tray. Burner shall also include a balanced flue design, gravity venting system for operation with either natural or LP gas at the inlet pressure indicated on the schedule. Each furnace shall be constructed with an aluminized steel casing with baked on enamel finish. Standard controls shall include a main gas pressure regulator, main modulating gas valve with 10 to 1 turndown, spark ignition, safety pilot, high limit, and 24 V control transformer. Electric ignition, standing pilots lights are unacceptable.

F. Motors and Drives: Motors shall be VFD rated energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy-duty type, matched to the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be cast and have machined surfaces, 10 horsepower and less shall be supplied with an adjustable drive pulley.

G. Electrical: All internal electrical components shall be pre-wired for single point power connection. All electrical components shall be UL listed, recognized or classified where applicable and wired in compliance with the National Electrical Code. Control center shall include motor starter, control circuit fusing, control transformer for 120 VAC circuit, integral door interlocking disconnect switch with separate motor fusing and terminal strip. Contactors, Class 20 adjustable overload protection and single phase protection shall be standard.

H. Filter Section: Filters shall be 2” MERV 13 mounted in a V-bank arrangement such that velocities across the filters do not exceed 550.0 feet per minute. Filters shall be accessible through a removable access panel. Filter quantities shall be provided as indicated in Part III.

I. Temperature Controls are to be furnished and installed by the ATC Contractor. Unit manufacturer shall provide terminal strips control devices not furnished by ATC contractor, including modulating gas valve. Refer to Specification Section 23 00 00 ATC control specification requirements and Control Diagram Drawings for Rooftop unit control requirements and expanded sequence of operation and required points list. HVAC and ATC Contractors shall coordinate with unit manufacturer to ensure all sequence of operation and control points are achieved with the BMS to complete the specified sequence of operation and points lists.

J. Weather Hood: Weather hood shall be constructed of G90 galvanized steel with birdscreen mounted at the intake.

K. Manufacturer: Subject to compliance with the above, provide Kitchen Make-Up Air Unit of one of the following:
1. Greenheck
2. Cook
3. Carnes
4. CaptiveAire
5. Or Equal.

2.16 TERMINAL HEATING UNITS (HYDRONIC) (Refer to section 018100 Commissioning for additional contract requirements)

A. Finned Tube Radiation:
1. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Cabinets: Minimum 18-ga cold-rolled steel full backplate, minimum 14-ga front. Brace and reinforce front minimum of 4'-0" o.c. without visible fasteners.

3. Elements: Copper tube and aluminum fins, or steel tube and steel fin (as scheduled) with tube mechanically expanded into fin collars to eliminate noise and insure durability and performance at scheduled ratings.
4. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel on fronts and accessories. Color as selected by Architect.
5. Accessories:
   a. End panels, inside and outside corners, and enclosure extension.
   b. Access panels in front of valves, balancing cocks, and traps.
   c. Factory-mounted dampers.
   d. Ball bearing hangers.

6. Manufacturer: Subject to compliance with requirements, provide finned tube radiation of one of the following:
   a. Slant/Fin Corp.
   b. Rittling
   c. Sterling Radiator; Div. of Reed National Corp.

B. Hydronic Convectors
1. General: Provide convectors having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Cabinets: Minimum 14-ga steel front and top panels, 18-ga side panels, and 20-ga back panels. Phosphatize and galvanize back panels, phosphatize and paint tops, sides, and fronts, with one coat of primer and factory finished baked enamel. Secure fronts in place with quick opening slide bolts or camlock fasteners.
   a. Recessed Cabinets: One-piece front panel, with 4-side gasketed overlap.
3. Elements: Aluminum fins, ribbed steel side plates, fin tube supports and copper tubes, cast-iron headers. Factory test each element to 150 PSI air pressure under water.
4. Accessories: Provide the following accessories.
   a. Factory-mounted dampers.
   b. 1/2" insulation on front
   c. Access doors in front for valve access.
5. Manufacturer: Subject to compliance with requirements, provide convectors of one of the following:
   a. Airtherm Mfg. Co.,
   b. American Air Filter Co.
   c. Burnham Corp.; Hydronics Div.
   d. Rittling
   e. Trane (The) Co.
   f. Or Equal.

C. Unit Heaters (UH) (Horizontal Type)
1. General: Provide horizontal unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Construction:
   a. Casings: Construct of steel, phosphatized inside and out, and finished with baked enamel. Provide adjustable face air diffuser.
   b. Fans: Construct of aluminum and factory-balance. Design so motor and fan assembly is removable through fan outlet panel.
   c. Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in hot water applications.
   d. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

3. Manufacturer: Subject to compliance with requirements, provide horizontal unit heaters of one of the following:
   a. Airtherm Mfg. Co.
   b. Rittling
   c. Trane (The) Co.
   d. Modine
   e. Or Equal.

D. Unit Heaters (UH) (Cabinet Type)
1. General: Provide cabinet unit heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
2. Construction:
   a. Chassis: Galvanized steel wrap-ground structural frame with edges flanged.
   b. Insulation: Faced, heavy density glass fiber.
   c. Cabinet: 14-ga removable front panel, 18-ga top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer and baked enamel finish paint with color as selected by Architect. Provide sample selection chart.
   d. Water Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi and leak test at 300 psi under water. Provide same end connections for supply and return.
   e. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.
   f. Motors: Provide shaded pole motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit. Provide three speed switch on fan motor.
   g. Filters: Provide 1" thick throwaway type filters in fiberboard frames.
3. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:
   a. McQuay Inc.
   b. Trane (The) Co.
   c. Young Radiator Co.
   d. Rittling
   e. Or Equal.

E. Radiant Heating Panels
1. Radiant Panels shall be manufactured of copper tubing and consisting of header pipes at each end.
2. Tube thicknesses shall be medium pressure – 0.058" min wall thickness.
3. Radiant Panel header pipes shall be square 0.109" min wall thickness and include all necessary supply, return, and air vent connections. Internal baffling shall be provided as required.
4. Piping connections shall be 3/4" NPT. Air vent connections shall be 1/8" NPT taper threaded sockets.
5. Working pressure shall be medium pressure – 85 psi max (Tested at 110 psi).
6. Radiant Panel expansion shall not exceed 0.016 inch per linear foot at 215°F.
7. Radiant Panels shall be cleaned and phosphatized in preparation for the powder coat finish.
8. Finish Style and Color of the Panel shall be selected by Architect from available standard or optional colors prior to ordering.
9. Ceiling mounting brackets shall be provided with radiation panels.

10. Radiation Panels shall have the sizes, capacities, and quantities as shown on the plans and schedules.
11. Install panel radiators in accordance with manufacturer's recommendations.
12. Provide manufactures standard connector and end cap pieces as required to provide a continuous appearance.
13. Manufactures: Sterling, Sun El, Runtal or Equal

2.17 TERMINAL HEATING UNITS (ELECTRIC) (Refer to section 018100 Commissioning for additional contract requirements)

A. Electric Propeller Unit Heaters (UH)
1. Materials and Equipment:
   a. General: Except as otherwise indicated, provide manufacturer's standard electric propeller unit heater materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for a complete installation.
2. Heating Elements:
   a. General: Except as otherwise indicated, provide manufacturer's standard heating elements of types, sizes, capacities, and ratings for duty indicated; consisting of resistance elements in steel sheath with extended fins, or with spirally finned sheath.
   b. Heating Capacity: Size elements for indicated fan speed, CFM, room heating load (BTUH), entering air temperature, and electric inputs (watts, voltage, phase).
3. Casings:
   a. General: Provide casings braced and reinforced to provide required stiffness, and with adjustable heating element supports and brackets. Provide rounded corners. Phosphatize and paint casings inside and out with single coat of baked-on enamel; and zinc plate hardware. Include fan orifice (venturi) in casing, as well as threaded hanger connections (weld nuts). Fabricate from 18-gage galvanized steel.
4. Air Deflectors:
   a. General: Provide manufacturer's standard air deflectors of the following types:
      1) 4-way finned louvers.
      2) Cone diffusers.
      3) Vane outlets.
      4) Louver outlets.
5. Motors:
   a. General: Provide totally enclosed shaded-pole, or permanent-split capacitor motors, Class "B" insulation, resiliently mounted, tap wound with built-in thermal overload protection, and with sleeve type or permanently lubricated ball bearings.
   b. Internal Electrical Wiring: Provide units with high temperature, heat-resistant electrical wiring enclosed in flexible metal conduit extending from terminal junction box to electrical devices. Provide fusing for motor and control circuit wiring.
   c. Devices: Provide propeller unit heaters with the following devices:
      1) Thermally activated fan switch to keep fan motor operating until residual heat is dissipated.
      2) Disconnect switch.
      3) Automatic reset, high limit cut-out switch located in discharge air stream.
      4) Magnetic contractor.
      5) Transformer.
6. Fans:
   a. General: Provide aluminum propeller fans which are balanced statically and dynamically, of indicated capacity. Provide fans suitable for standard or sparkproof application.

7. Manufacturers: Subject to compliance with requirements, provide propeller unit heaters of one if the following:
   a. Chromalox Div.; Emerson Electric Co.
   b. Federal Pacific Electric Co.
   c. Gould Inc.
   d. Markel Nuton Div.; Scoville Inc.
   e. TPI Corporation.
   f. Qmark
   g. Or Equal.

2.18 POWER AND GRAVITY VENTILATORS (Refer to section 018100 Commissioning for additional contract requirements)

A. General: Except as otherwise indicated, provide standard prefabricated power and gravity ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

B. Refer to Division-23 automatic temperature control for control sequence.

C. Roof Fans (EF)

1. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, or galvanized steel, weatherproof housings as scheduled. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans.
2. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
3. Bird Screens: Provide removable bird screens, 1/2" mesh, 16-ga. aluminum or brass wire.
4. Motor Operated Dampers: Provide louvered dampers with linkage below curb base (maximum of 6").
5. Manufacturer: Subject to compliance with requirements, provide centrifugal roof ventilators of one of the following:
   a. Carnes Co., Div. of Wehr Corp.
   b. Cook Co., Loren.
   c. Greenheck Fan Corp.
   d. Penn Ventilator Co., Inc.
   e. Power Line Fans; Div. of Torin Corp.

D. Propeller Wall Fans (EF)

1. Type: Propeller fan, direct or belt driven as scheduled. Provide extruded-aluminum blades. Fasten to die-cast hub. Provide wall sleeve, of length to suit wall thickness. Provide permanent split-capacitor type motor for direct driven fans, capacitor-start, induction-run type motor for belt driven fans.
2. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
3. Motor Cage: Provide removable motor cage of 1/2" x 1" mesh, 16-ga. vinyl coated wire.
4. Dampers: Provide gravity operated louvered backdraft damper in wall sleeve.
5. Manufacturer: Subject to compliance with requirements, provide propeller wall ventilators of one of the following:
   a. Acme Engineering & Mfg. Corp.
   b. Briedert Co., C.G.

c. Carnes Co., Div. of Wehr Corp.
d. ILG Industries, Inc.
e. Penn Ventilator Co., Inc.
f. Power Line Fans; Div. of Torin Corp.
g. Swartwout Industries Inc.
h. Or Equal.

E. Centrifugal In-Line Fans (EF)

1. General: Fans shall be of the centrifugal belt or direct driven in-line type. Units shall bear AMCA label.
2. Fan Housing: Shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars. Unit shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.
3. Fan Wheel: Shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.
4. Motors: Shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase, and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.
5. Shafts and Drives: Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L50) life in excess of 200,000 hours at maximum cataloged operating speed. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing. A NEMA 1 disconnect switch shall be provided, factory wired.
6. Manufacturer: Subject to compliance with requirements, provide centrifugal in-line fans of one of the following:
   a. Greenheck Fan Corp.
   b. Carnes CO., Div. of Wehr Corp.
   c. Cook Co., Loren.
   d. Penn Ventilator Co., Inc.
   e. Power Line Fans; Div. of Torin Corp.
   f. Or Equal.

F. Laboratory Exhaust Fans

1. General
   a. Base fan performance at standard conditions (density 0.075 Lb/ft3).
   b. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
   c. Each fan shall be belt driven.
   d. Fans to be equipped with lifting lugs.
   e. Fan to be coated steel with a minimum of 4 mils of Hi-Pro Polyester Resin. Color to be gray.
   f. Fasteners to be stainless steel.
   g. Fan assembly shall be designed for a minimum of 125 MPH wind loading, without the use of guy wires.

2. Corrosion Resistant Coating
   a. All fan and system components (fan, nozzle, wind band, plenum) shall be corrosion resistant coated with LabCoat™, a two part electrostatically applied and baked, sustainable, corrosion resistant coating system; or Heresite P-413C. Standard finish color to be gray.

b. All parts shall be cleaned and chemically prepared for coating using a multi-stage wash system which includes acid pickling that removes oxide, increases surface area, and improves coating bond to the substrate.
c. The first powder coat applied over the prepared surface shall be a zinc rich epoxy primer (no less than 70% zinc) and heated to a gelatinous consistency (partial cure) at which the second powder coat of polyester resin shall be electrostatically applied and simultaneously be cured at a uniform temperature of 400°F.
d. The coating system shall not be less than a total thickness of 6 mils, is not affected by the UV component of sunlight (does not chalk), and has superior corrosion resistance to acid, alkali, and solvents. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.
e. Note that 10-20 mil thick wet coating systems pollute the environment (air and water), and that these manually applied coatings are not uniform over the impeller surface and can cause fan imbalance and vibration.

3. Fan Housing And Outlet
   a. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
   b. Fan housing shall be welded steel with a minimum of 4 mils of Hi-Pro Polyester Resin. No uncoated metal fan parts shall be acceptable.
   c. Fan housings that are fabricated of polypropylene or fiberglass that have lower mechanical properties than steel, have rough interior surfaces in which corrosive, hazardous compounds can collect, and / or which chalk and structurally degrade due to the UV component of the sunlight shall not be acceptable.
   d. A high velocity conical discharge nozzle shall be supplied by the fan manufacturer and be designed to efficiently handle an outlet velocity of up to 6000 FPM. Discharge stack caps or hinged covers, impeding exhaust flow shall not be permitted.
   e. Provide housing drain for removal of rain and condensation.
   f. A bolted and gasketed access door shall be supplied in the fan housing allowing for impeller inspection or removal of impeller, shaft and bearings without removal of the fan housing.
   g. Standard finish color to be gray.
4. Fan Impeller
   a. Fan impeller shall be centrifugal, backward inclined, with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically per AMCA Standard 204.
   b. Fan impeller shall be manufactured of aluminum (AMCA type B spark resistant), fully welded and meet specification section 2.15 for corrosion resistant coating.
5. Fan Bypass Air Plenum
   a. For constant volume systems, the fan shall be connected directly to the exhaust duct without the need of a bypass air plenum.
   b. For variable volume systems, a bypass air plenum shall be provided. The plenum shall be equipped with a bypass air damper and intake air hood with bird screen for introducing outside air at roof level upstream of the fan.
   c. The plenum shall be constructed of fully welded steel, meet specification section 2.15 for corrosion resistant coating, and mount on roof curb as shown on the project drawings. Plenums that are fabricated of plastics or resins that are combustible and have mechanical properties less than steel shall not be acceptable.
   d. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer, as shown on the project drawings (see section 2.5)
   e. Fan designs that use inlet flexible connectors that can leak causing loss of lab exhaust shall not be accepted.
   f. Bypass air dampers shall be opposed-blade design, and coated with a minimum of 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked.

g. A fan isolation damper, either gravity back draft or two position actuated, fabricated of steel or aluminum and coated with minimum 4 mils of Hi-Pro Polyester resin, electrostatically applied and baked, shall be provided as shown on the project documents.
h. Blower / Plenum vibration isolation shall be limited to neoprene / cork vibration pads.

6. Bypass Air Plenum Curb
   a. Exhaust system manufacturer shall supply a structural support curb for the plenum, of specified height, as shown on the drawings.
   b. Curb shall be fabricated of a minimum of 12 gauge corrosion resistant coated steel and structurally reinforced.
   c. Curbs shall be insulated.
   d. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.
7. Fan Motors And Drive
   a. Motors to be premium efficiency, standard NEMA frame, TEFC with a 1.15 service factor. A factory mounted NEMA 3R disconnect switch shall be provided for each fan. Motor maintenance shall be accomplished without fan impeller removal or requiring maintenance personnel to access the contaminated exhaust components.
   b. Drive belts and sheaves shall be sized for 200% of the motor horsepower, and shall be readily and easily accessible for service, if required. Drive shall consist of a minimum of two belts under all circumstances.
   c. Shaft to be polished and ground steel.
   d. Fan shaft bearings shall be Air Handling Quality, ball or roller pillow block type and be sized for an
      L-10 life of no less than 100,000 hours. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.
   e. All shaft bearings shall have extended lube lines with zerk fittings.
8. Installation
   a. Install fans as indicated, with flexible electrical leads.
   b. Pipe housing drain to nearest drain.
   c. Install fans in accordance with manufacturer's instructions.
9. Acceptable Manufacturers
   a. Greenheck Fan Corp, Model Vektor High Plume Laboratory Exhaust System (as scheduled)
   b. Strobic Air
   c. MK Plastics
   d. Approved equal.

G. Roof Hoods (RH)
1. Type: Stationary, natural draft type. Provide weatherproof housings to match power ventilators in materials and finish. Provide square or rectangular base to suit roof curb.
2. Bird Screens: Provide removable bird screens, 1/2" mesh, 16-ga aluminum or brass wire.
3. Motor Operated Dampers: Provide dampers with linkage below curb base (maximum of 6"). Refer to Division 23 Automatic Temperature Control section for control sequence.
4. Manufacturer: Subject to compliance with requirements, provide gravity ventilators of the following:
   a. Carnes Co., Div. of Wehr Corp.
   b. Cook Co., Loren.
   c. Penn Ventilator Co,. Inc.
   d. Power Line Fans; Div. of Torin Corp.
   e. Greenheck Fan Corp.
   f. Or Equal.

H. Prefabricated Roof Curbs
1. Manufacturer of ventilating unit shall provide his standard 18" high roof curb compatible with unit being provided. Curb shall be insulated and sloped to allow for level installation of device. Provide all necessary nailers, cants, etc. for a complete installation.

2.19 METAL DUCTWORK (Refer to section 018100 Commissioning for additional contract requirements)

A. Ductwork Materials:
1. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including piping, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
2. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality, with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.
3. Stainless Steel Sheet: Where indicated, provide stainless steel complying with ASTM A 167; Type 302, 304, or 316; with No. 1 finish elsewhere. Protect finished surfaces with mill-applied adhesive protective paper, maintained through fabrication and installation. For exposed stainless steel ductwork, provide matching stainless steel support materials.
4. Aluminum Sheet: Dishwasher exhaust shall be constructed of aluminum sheet complying with ASTM B 209, Alloy 3003, Temper H14. Dishwasher exhaust shall have all seams soldered vapor tight. For aluminum ductwork, provide aluminum support materials.

B. Miscellaneous Ductwork Materials:
1. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
2. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15 degree change of direction per section. Unless specifically detailed otherwise, use 45 degree laterals and 45 degree elbows for branch takeoff connections. Where 90 degree branches are indicated, provide conical type tees.
3. Duct Liner: Refer to "Acoustic Duct Lining Section".
4. Duct Liner Adhesive: Comply with ASTM C 916 "Specification for Adhesives for Duct Thermal Insulation".
5. Duct Liner Fasteners: Comply with SMACNA HVAC Duct construction Standards, Article S2.11.
6. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation details, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.
7. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
8. Flexible Ducts: Corrugated aluminum complying with UL 181.
a. Where installed in unconditioned spaces other than return air plenums, provide 1 1/2" (R-5) thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.

C. Fabrication:
1. Shop fabricated ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated or required to complete runs. Preassembled work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
2. Shop fabricated ductwork of gages and reinforcement complying with SMACNA "HVAC Duct Construction Standards".

3. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1-1/2 times associated duct width; or squared metered elbows with double thickness turning vanes. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
4. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to section "Ductwork Accessories" for accessory requirements.
5. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.

D. Factory-Fabricated Low Pressure Round And Oval Ductwork:
1. General: Provide factory-fabricated duct and fittings.
2. Material: Material type shall be as indicated or, galvanized sheet steel complying with ASTM A 527, lock forming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.
3. Gage: 28-gage minimum for round and oval ducts and fittings, 4" through 24" diameter.
4. Seams: All seams shall be spiral lockseams.
5. Elbows: One piece construction for 90 degrees and 45 degree elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.
6. Divided flow Fittings: 90 degree tees, constructed with saddle tap spot welded and bonded to duct fitting body.
7. Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork of one of the following:
   a. Semco Mfg., Inc.
   b. United Sheet Metal Div., United McGill Corp.

E. Kitchen Exhaust Ducts:
1. General: Fabricate kitchen hood exhaust ducts and supports, used for smoke and vapor removal from cooking equipment, of 16-ga minimum carbon steel where concealed, and of 18-ga minimum stainless steel where exposed. For duct construction and installation requirements, comply with SMACNA "HVAC Duct Construction Standards", and NFPA 96 "Standard for Ventilation Control and Fire Protection of Commercial Cooling Operations" latest approved edition.

F. Laboratory Exhaust Ducts:
1. General: Fabricate laboratory exhaust ducts and supports of 18-ga minimum 316L stainless steel. All joints shall be welded. For duct construction and installation requirements, comply with SMACNA "HVAC Duct Construction Standards". Laboratory exhaust ductwork shall be provided with (2) 1 ½" layers of calcined kaolin similar to Nelson "FSB" flamsheild blanket to achieve a 2 hr. rating when ductwork is not routed in a rated enclosure. refer to architectural plans for locations of laboratory exhaust ductwork and architectural enclosure details.

2.20 DUCTWORK ACCESSORIES (Refer to section 018100 Commissioning for additional contract requirements)

A. Dampers:
1. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct construction Standards".
2. Automatic Control Dampers: Refer to Division 23 section "Automatic Temperature Control" for control dampers; not work of this section.

3. Backdraft Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at .05" static pressure. Construct blades of 16-ga. aluminum; provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct from 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under: 4" x 1-1/4" x 16 ga. channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up. Provide felted or rubber trim to assure tight, leak-proof seal when closed.
4. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
   a. Air Balance, Inc.
   b. Airguarde Corp.
   c. American Warming & Ventilating, Inc.
   d. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
   e. Louvers & Dampers, Inc.
   f. Penn Ventilator Co.
   g. Ruskin Mfg. Co.
   h. Or Equal.

B. Fire Dampers:
1. Fire Dampers: Provide fire dampers, of types and sizes indicated. Construct casings of 11-ga. galvanized steel. Provide fusible link rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide out of air stream type damper in open position and with positive lock in closed position with stainless steel heat treated type 301 closure spring, and with the following additional features:
   a. Damper Blade Assembly: Curtain type.
   b. Blade Material: Steel, match casing.
   c. Blade Material: Stainless steel.
2. Combination Fire/Smoke Dampers: Provide fire/smoke dampers, of types and sizes indicated. Construct casing of 11-ga. galvanized steel with bonded red acrylic enamel finish. Provide fusible link rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide additional frangible link containing explosive charge, connected in series with fusible link. Provide stainless steel spring loaded leakage seals in sides of casing, and 36" long wire leads for connecting smoke link to smoke detector, and the following additional features:
   a. Damper Blade Assembly: Single-blade type.
   b. Damper Blade Assembly: Multi-blade type.
   c. Damper Blade Assembly: Curtain type.
   d. Blade Material: Steel, matching casing.
   e. Blade material: Stainless steel.
3. Motor-Driven Fire/Smoke Dampers: Provide motor-driven fire/smoke dampers in types and sizes indicated, with casing constructed of 11-ga. galvanized steel with bonded red acrylic enamel finish, fusible link 160 to 165 degrees F (71 to 74 degrees C), unless otherwise indicated, and curtain type stainless steel interlocking blades, with electric motor equipped with instant closure clutch, stainless steel cable damper blade linkage, motor mounting bracket, and 32" long wire leads for connecting to smoke detector, and with the following construction features:
   a. Unit Assembly: Motor mounted outside air stream.
4. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:
   a. Air Balance, Inc.
   b. American Warming & Ventilating, Inc.
   c. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
   d. Louvers & Dampers, Inc.
   e. Penn Ventilator Co.
   f. Phillips-Aires

g. Ruskin Mfg. Co.
h. Or Equal.

C. Turning Vanes:
1. Manufactured Turning Vanes: Provide double thickness airfoil turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c, and set into side strips suitable for mounting in ductwork.
2. Manufacturer: Subject to compliance with requirements, provide turning banes of one of the following:
a. Aero Dyne Co.
b. Airsan Corp.
c. Anemostat Products Div.; Dynamics Corp. of America.
d. Barber-Colman Co.
e. Duro Dyne Corp.
f. Environmental Elements Corp.; Subs, Koppers Co., Inc.
g. Hart & Cooley Mfg. Co.
h. Register & Grille Mfg. Co., Inc.
i. Souther, Inc.
j. Or Equal.

D. Duct Hardware:
1. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
a. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
b. Quandrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
2. Manufacturer: Subject to compliance with requirements. Provide duct hardware of one of the following:
a. Ventfabrics, Inc.
b. Young Regulator Co.
c. Or Equal.

E. Duct Access Doors:
1. General: Provide duct access doors of a size as required to service and maintain device in duct. All access doors to be a minimum of 12”x12” and to be gasketed and installed air tight. Provide on (1) access door at each control damper, humidifier, coil, fire damper, and any device that requires attention.
2. Construction: Construct of same or greater gage as ductwork served, provide insulted doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.
3. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
a. Air Balance, Inc.
b. Duro Dyne Corp.
c. Register & Grille Mfg. Co., Inc.
d. Ruskin Mfg. Co.
e. Ventfabrics, Inc.
f. Zurn Industries, Inc.; Air Systems Div.
g. Or Equal.

F. Flexible Connectors:
   1. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
   2. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:
      a. American/Elgen Co.; Energy Div.
      b. Duro Dyne Corp.
      c. Flexaust (The) Co.
      d. Ventfabrics, Inc.
      e. Or Equal.

2.21 ACOUSTIC DUCT LINING

A. Lining for Rectangular Metal Ducts: All ducts, where shown or noted on the drawings, shall be lined with 1"-1 ½" (r-5) thick hospital grade liner similar to "Permacote Linacoustic HP" fiberglass duct liner with factory-applied surface and edge coating. The liner shall meet the Life Safety Standards as established by NFPA 90A and 90B, FHC 25/50 and Limited Combustibility and the airstream surface coating should contain an immobilized, EPA-registered, anti-microbial agent so it will not support microbial growth as tested in accordance with ASTM G21 and G22. The duct liner shall conform to the requirements of ASTM C 1071 and C1104, with an NRC not less than .75 as tested per ASTM C 423 using a Type "A" mounting, and a thermal conductivity no higher than .24 at 75EF mean temperature.

B. Material Handling and Storage: Liner shall be kept clean and dry during transportation, storage and installation. Care should be taken to protect the liner from exposure to the elements or damage from mechanical abuse.

C. Manufacturer: Subject to compliance with the above provide duct sound lining in accordance with the above performance criteria description.

2.22 SOUND ATTENUATORS (SA)

A. General: Provide factory-fabricated and tested duct silencers as indicated, select with performance characteristics which match, or exceed those indicated on schedule.

B. Casings: Construct of sheet metal, with gage and seam construction equal or greater than that recommended by SMACNA-Duct Construction Standards for ductwork of same size and pressure class; but not less than gauge dimension recommended by manufacturer based upon application (or 16-gage for outer casing and 22-gage for inner casing).

C. Acoustic Fill: Provide inorganic mineral or glass fiber filler material, inert, vermin and moisture proof, of sufficient density to obtain specified acoustic performance. Pack under not less than 5% compression to eliminate voids due to vibration and settling. Acoustic fill shall be covered and protected with hospital grade film type liner.

D. Acoustic Performance: Provide silencer ratings that have been determined in such to reverberative room test facility. Test silencer with air flow in both directions through silencer, in accordance with ASTM E477, "Methods of Testing Duct Liner Materials and Prefabricated Silencers for Acoustical and Airflow Performance."
   1. For acoustic ratings, include Dynamic Insertion Loss and Self Noise Power Levels for both forward flow (air and noise in same direction) and reverse flow (air and noise in opposite directions) with airflow of at least 2,000 FPM face velocity.

E. Aerodynamic Performance: Provide silencers with static pressure loss equal to or less than that scheduled.

F. Certification: Provide certified test data on Dynamic Insertion Loss, Self-Noise Power Levels, and Aerodynamic Performance. Conduct all rating tests at same facility. Open testing facility for inspection by Architect/Engineer if requested.

G. Manufacturers: Subject to compliance with requirements, provide duct silencers of one of the following:
   1. Vibro-Acoustics
   2. Aeroacoustic Corporation
   3. Industrial Acoustics Co.
   4. Price
   5. Or Equal.

2.23 AIR OUTLETS AND INLETS (Refer to section 018100 Commissioning for additional contract requirements)

A. Ceiling Air Diffusers:
   1. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Stamped face diffusers will not be acceptable.
   2. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw, drop and noise criteria ratings for each size device as listed in manufacturer's current data.
   3. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
   4. Types: Provide ceiling diffusers of type, capacity, throw, blow and with accessories as listed on diffuser schedule.
      a. Ceiling Diffusers shall be of the restricted multi-orificed jet induction and air mixing type consisting of louver sections with built-in diffusing vanes. The vanes shall be arranged to discharge air from adjacent louvers at an angle of 45 degrees in opposite directions to insure rapid mixing of primary and room air. Diffusing vanes shall be welded and mechanically fastened to the adjacent louver sections to make a rigid unit. The vanes shall extend to the discharge edges of the louvers. Where louver sections join the core frame, the louver ends shall be welded to the core frame. The leaving edge of each louver shall be hemmed and the louver ends shall be rounded and hemmed before welding to the core frames.

b. Diffusers shall be fabricated of aluminum or steel-welded construction, and shall be provided with a removable core permitting easy access to the neck connection. The diffuser neck shall extend no less than 1" above the core to accommodate an internal duct connection to prevent leakage into the ceiling space.
c. Finish shall be baked enamel. Color as selected by A/E.

5. Diffuser Dampers:
   a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser. Provide in each ceiling diffuser.
6. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:
   a. Tuttle & Bailey Agitair Series
   b. Metalaire – “5000 IV”
   c. Price
   d. Or Equal.

B. Wall Registers and Grilles:
1. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicted, and as required for complete installation.
2. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
3. Compatibility: Provide registers and grilles with border styles that are compatible with adjacent systems, and that are specifically manufactured to fit into wall and ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.
4. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule:
5. Pattern: Register and grille patterns shall have style as identified on Drawings:
6. Dampers: Opposed Blade adjustable assembly, key operated from face of register.
7. Accessories:
   a. Plaster Frame: Perimeter frame designed to act as plaster stop and register or grille anchor. Provide where required.
   b. Operating Keys: Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustment.
8. Finish: Register and Grille Finishes shall be baked enamel color as selected by the Architect.
9. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one the following:
   a. Agitair (Air Devices)
   b. Metalaire
   c. Price
   d. Or Equal.

C. Ceiling Registers and Grilles:
1. General: Except as otherwise indicated, provide manufacturer's standard "Egg-Crate" type registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
2. Compatibility: Provide registers and ceiling grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling construction.

3. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.
4. Register and Grille Materials:
   a. Aluminum Construction: Manufacturer's standard extruded aluminum frame and core.
5. Register and Grille Faces:
   a. 1/2" x 1/2" "Egg-Crate" with 1" border frame.
6. Register and Grille Dampers:
   a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of register (provide for registers only).
7. Register and Grille Finishes shall be baked enamel color as selected by the Architect.
8. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one of the following:
   a. Agitair (Air Devices)
   b. Metalaire
   c. Price
   d. Or Equal.

D. Displacement Diffuser (1 way, 1 way corner, rectangular industrial)
1. General: Displacement Diffuser shall be constructed with an equalization baffle behind the operative diffuser face for uniform, low velocity, distribution of supply air. Both the equalization baffle and face shall be securely retained in the diffuser frames. Diffuser Manufacturer shall provide sound and pressure drop data derived from tests in accordance with ASHRAE standard 70-1991. Performance data for adjacent zone shall be provided based on test in accordance with Nordtest method, Air Terminal Devices: Aerodynamic Testing + Rating at Low Velocity NT VVS 083.
2. Material: The diffuser frames shall be constructed of high strength aluminum extrusion for rigidity and protection of the operative face and side panels. There shall be no visible fasteners on the front or side panels. The operative face shall be constructed of painted high-gauge steel, side and end panels may be provided in painted steel. All perforated materials shall be fastened to the frame with vibration dampening. The frame and internal baffling elements shall be constructed of Aluminum. The paint shall be powder coat polyester. Epoxies and their derivatives are unacceptable. Visible non-metallic components are unacceptable. The diffuser shall be supplied with concealed mounting brackets that do not require puncturing the diffuser to install. Paint Factory Finish Color shall be as selected by Architect. Submit color selection chart to architect as part of submittal package.
3. Base: Supply and install a base under each displacement diffuser. The base shall be manufactured by the displacement diffuser manufacturer. The base shall allow for removal from the space for access to inlet of the diffuser. The base shall have an extruded alumni mum frame and 22 gauge solid steel face. Base heights shall be as indicated on the drawings. Finish shall match adjacent Diffuser color.
4. Manufacturer: Subject to compliance with requirements, provide flat faced displacement diffusers of one of the following:
   a. Price
   b. Metalaire
   c. Trox
   d. Or Equal.

E. Displacement Diffuser (Floor)
1. Supply and install Price ARFHD or equal round floor displacement diffusers of the sizes, configurations, and capacities indicated on the drawing and/or diffuser schedule. Each diffuser shall produce a low induction horizontal flow resulting in a stratified zone temperature distribution within the
occupied zone.

2. The discharge airflow shall be adjustable from the face of the diffuser. Minimum flow limit shall be adjustable from 0% to 50% of maximum flow using a mechanical stop. The adjustable diffuser face shall have a positive interlock with the mounting hardware to reduce the chance of accidental adjustment due to foot traffic.
3. The 8" core shall be constructed of aluminum able to withstand maximum mechanical loading of 3000 lbs.
4. Round floor diffusers shall be installed with Ring Press Fit fastening and shall include tamper protection to prevent unauthorized removal of the round diffuser. Assembly shall include black polycarbonate Standard Distributor Basket with Damper device.
5. Factory Finish color shall be selected by Architect. Submit color matrix chart for Architect's review and approval.
6. Manufacturer: Subject to compliance with requirements, provide flat faced displacement diffusers of one of the following:
   a. Price
   b. Halton
   c. Trox
   d. Or Equal.

F. Linear Diffusers
1. Linear slot diffusers shall be furnished and installed as indicated on the drawings.
2. Provide shop drawings accompanied by itemized list indicating units' location and appropriate product submittal drawings provided by the manufacturer.
3. Exact dimensions of walls and ceiling are as per the architectural drawings. Install diffusers so they fit properly in the ceiling system with suspension wire (48" o/c MAX.) and/or attachment plates — as required.
4. Coordinate installation with General Contractor and other sub-contractors.
5. The linear slot diffuser shall utilize heavy wall extruded aluminum air deflector frames. These frames shall be designed to accommodate notched compressible space bars, complete with integral hanger, spaced approximately 24" on center. The steel air pattern controllers are fully adjustable and can be moved from side to side to create various air pattern configurations. These dual pattern controllers shall be fully adjustable to allow shut-off without adding any blank-off devices. The spacer bars and pattern controllers shall be removable for on-site modification and trimming.
6. The Linear slot diffuser shall be complete with factory end conditions as shown or indicated.
7. Supply air engineered plenums shall be provided and manufactured of heavy gauge wipe coat steel. These units shall be insulated with a side inlet collar.
8. When engineered plenum end caps cannot positioned directly over the linear spacer bar due to field conditions, install MB Blank-Off from plenum end cap to next spacer bar.
9. MB Blank-Off shall be manufactured of heavy gauge steel painted black.

G. Drum Type Diffusers
1. Furnish and install Price model HCD2D or Equal supply outlets of the sizes and models indicated on the plans and outlet schedule.
2. The outlets shall consist of individually adjustable spread control vanes housed within a rotatable drum.
3. The vanes shall be bisected by a center divider allowing separate adjustment of top and bottom blades. The end panels of the drum shall incorporate spread control members to enhance pattern control.
4. Curved outer drum and vanes extruded aluminum, other components are steel. The drum pivot mechanism shall incorporate a positive positioning, detent device to hold field adjusted drum angles of up to 30° off center.
5. Adjustable vanes are to pivot and maintain blade setting border shall be constructed of formed steel with welded, reinforced corners for extra strength. Screw holes shall be countersunk for aesthetic appeal.

6. The integral volume control damper shall be of the opposed blade type and shall be constructed of cold rolled steel. Damper shall be operable from the register face. The damper shall be coated steel. The unit shall be finished in (B12 White Powder Coat / B15 Aluminum Powder Coat) in color as determined by the architect.

2.24 DUCTLESS COOLING UNITS (Refer to section 018100 Commissioning for additional contract requirements)

Evaporator (Stand-Alone):

A. General: The unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board, and fan motor. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from factory.

B. Cabinet: The casing shall be ABS plastic factory finish. Cabinet shall be designed for suspension mounting and horizontal operation. The rear cabinet panel shall have provisions for a field installed filtered outside air intake connection.

C. Fan: The evaporator fan shall have three high performance, double inlet, forward curve sirocco fans driven by a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of four (4) speeds: Low, M1, M2 and Hi.

D. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall provide a choice of five (5) vertical airflow patterns selected by remote control. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

E. Filter: Return air shall be filtered by means of an easily removable washable filter.

F. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

G. Control: The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. For A-Control, a three (3) conductor 14 ga. AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. Where separate power is supplied to the indoor and outdoor units, a two (2) 20 ga. AWG wire shall be run between the units to provide forbid-directional control communication. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

H. Condensing (Stand Alone):
   1. General: The outdoor unit shall be equipped with a control board that inferfaces with the indoor unit to perform all necessary operation functions. The outdoor unit shall be capable of operating at 0°F, (-18°C) ambient temperature without additional low ambient controls. The outdoor unit shall be able to operate with a maximum height difference of 100 feet and have maximum refrigerant tubing length of 165 feet between indoor and outdoor units without the need for line size changes, traps or additional oil. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
   2. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a factory finish. The fan grille shall be of ABS plastic.
   3. Fan: The fan motor shall be of aerodynamic design fro quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across if from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.
   4. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.
   5. Compressor: The compressor shall be a scroll compressor with variable speed inverter technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.
   6. Electrical: The electrical power of the unit shall be as indicated on the drawings. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

I. Variable Volume Refrigerant Ductless Cooling Systems
   1. General
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Basis of Design: Sanyo ECOi Variable Refrigerant Flow (VRF) System.
         2) Mitsubishi CityMulti
         3) Daikin AC
         4) Or Equal.
         5) Written prior approval required for alternate VRF System Manufacturer.
      b. Written prior approved alternate manufacturer is required to coordinate any changes from the basis of design with all associated trades. Any additional costs associated with the alternate equipment shall be covered by the HVAC contractor or equipment manufacturer. No additional costs shall be incurred by the owner.
      c. Shop drawings shall be submitted in accordance with 013300. Submittals should include equipment cutsheet information, proposed piping design layout and list of materials. Submittals shall be prepared by an authorized system designer and distributer.

2. Refrigerant Components
   a. The equipment specified in this section shall operate with refrigerant R410A - no exceptions or substitutions.
   b. The system shall utilize fully modulating electronic expansion valves.
   c. All units and refrigerant pipes shall be charged with dehydrated air prior to shipment from the factory.
   d. All refrigerant lines shall be insulated from the outdoor unit to the indoor units served.
   e. The system shall be capable of operating with refrigerant piping up to 574 equivalent feet, a total combined length of 984 feet of piping between the condensing and fan coil units with 164 feet maximum vertical difference, without any oil traps or additional equipment. The vertical difference shall not exceed a maximum of 131 feet where the outdoor unit is located below the indoor unit.

3. Field Quality Control
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field assembled components and equipment installation, including connections, and to assist in field testing.
   b. Perform the following field tests and inspections and prepare test reports:
      1) Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
      2) Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
      3) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
      4) Remove and replace malfunctioning units and retest as specified above.
      5) The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label. All wiring shall be in accordance with the National Electrical Code (N.E.C.). The units shall be manufactured in a facility registered to ISO 9001 and ISO14001.
4. Delivery, Handling and Storage - Unit shall be stored and handled according to the manufacturer's recommendation.
5. Warranty
   a. The units shall be covered by the manufacturer's limited warranty for a period of two (2) years from date of installation.
   b. Additionally, the compressor shall have a manufacturer's limited warranty for a period of five (5) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.
6. Variable Refrigerant Flow System (R410A 2-WAY VRF SYSTEM)
   System shall be a VRF (variable refrigerant flow) multi split air conditioning system. The system will utilize an air cooled condensing unit supplying a maximum of forty indoor fan coil units with combinations of outdoor units 3 - 25 Ton capacity with a maximum of 2 outdoor units connected at one time for 208-230V/ 3 Phase service.

7. Heat Pump Condensing Unit (R410A 2-WAY VRF SYSTEM)
   a. The basis of design shall be Sanyo ECOi Model CHX outdoor unit. Acceptable manufacturers, subject to compliance with meet project specification requirements, include: Sanyo, Mitsubishi and Daikin AC
      1) The outdoor unit will have up to 3 air cooled heat exchange coils constructed from copper tubing with aluminum fins. The coils will be set in a vertical formation with air being drawn in through three sides of the unit and discharged out of the top of the unit. The Ecoi systems will have a single fan mounted on top of the three coils. The coils will be capable of being divided in to a maximum of 3 sections to enable the outdoor unit capacity to match the capacity required by the indoor units and to allow individual defrosting take place when required.
      2) The outdoor unit will have one inverter controlled hermetic twin rotary compressor and up to two high efficiency scroll constant speed compressors depending on selected unit type. Single compressor systems are not acceptable. Partial capacity cooling/heating capability must be available in the case of a compressor failure. The system shall use Sanyo's Roadmap control sequence to ensure that indoor loads are matched to compressor capacity control.
      3) The refrigeration process of the outdoor unit will be maintained by pressure and temperature sensors controlling solenoid valves check valves and bypass valves. The heating or cooling mode of the outdoor unit will be controlled using a combination of 2 & 3 way valve's which will reverse the cycle of the refrigerant to change the mode of the outdoor unit.
   b. The variable capacity, heat pump air conditioning system shall be variable refrigerant flow split system. The system shall consist of multiple evaporators using PID control and inverter driven outdoor unit. The unit shall consist of direct expansion (DX), air-cooled heat pump air conditioning system, variable speed driven compressor multi zone split system. The outdoor unit may connect an indoor evaporator capacity of 50-130% to that of the outdoor condensing unit capacity. Each indoor unit shall be capable of operating separately with individual temperature control.
   c. The outdoor unit shall be interconnected to indoor unit types specified in this section. The indoor units shall be connected to the outdoor units utilizing the specialized piping joints and headers provided by the equipment manufacturer.
   d. General: The outdoor unit is designed specifically for use with manufacturer's components:
      1) Refrigerant: R410a.
      2) The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of a Sanyo rotary compressor, motors, fans, condenser coil, electronic expansion valve, solenoid valves, 4 way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receivers and accumulators.
      3) Both liquid and suction lines shall be individually insulated between the outdoor and indoor units.
      4) The outdoor unit shall be wired and piped with outdoor unit access from left, right, rear or bottom.
      5) The connection ratio of indoor units to outdoor unit shall be 50% to 130%.
      6) The sound pressure dB(A) at rated conditions shall be a value of 55-62 decibels at 3 feet from the front of the single condensing unit. The outdoor unit shall be capable of operating at further reduced noise in 'Quiet Mode' (52-59 dB).

7) The system shall automatically restart operation after a power failure and shall not cause any settings to be lost, thus eliminating the need for re-programming.
8) The outdoor unit shall be modular in design and should allow for side-by-side installation with minimal spacing.
9) The following safety devices shall be included on the condensing unit: high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic, occurring 1 hour after system start up, every 6 hours of system operation or as required to maintain oil levels at the system condensing unit.
10) The outdoor unit shall operate in heating mode to -4 degrees F dry bulb ambient temperature without additional ambient controls

e. Unit Cabinet:
1) The outdoor unit model shall be completely weather proof and corrosion resistant. The outdoor unit will be constructed from steel plate and treated with acrylic paint silky shade (1Y 8.5 / 0.5)

f. Fan:
1) The condensing unit shall consist of two propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.
2) The fans shall be a vertical discharge configuration (horizontal discharge for CHX03652/CHDX06052 208/230V Single Phase Units).
3) The fan motors shall have inherent protection and permanently lubricated bearings and be mounted.
4) The fan motors shall be provided with a fan guard to prevent contact with moving parts.

g. Condenser Coil:
1) The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

h. Compressor:
1) The rotary compressor shall be variable speed control capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the condensing unit.
2) The inverter driven compressor in each condensing unit shall be of highly efficiency DC, hermetically sealed, rotary type compressor.
3) The capacity control range shall be a minimum of 20% to 100% of total capacity.
4) Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
5) Oil separators shall be standard with the equipment together with an oil balancing circuit.
6) The compressor shall be mounted to avoid the transmission of vibration.

i. Electrical:
1) The power supply to the outdoor unit shall be 208/230 volts, 3 phase, 60 hertz with a voltage range of 187 volts to 253 volts.
2) The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one 2-cable shielded communications wire, thus simplifying the wiring operation.

8. Indoor Air Handling Units (R410a 2-Way VRF System)
a. It shall be possible for the total connected capacity of the indoor units to be between 50 and 130% of the capacity of the outdoor unit.

b. Each indoor unit will have a heat exchanger which shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger will be controlled by an electronic proportional expansion valve. This valve will be controlled by two pipe thermistors, a return air and discharge air thermistor and shall be capable of controlling the variable capacity of the indoor unit between 25% and 100%.

c. Each indoor unit shall have an operating voltage of as scheduled on the drawings. The indoor unit shall supply demand capacity information to the outdoor unit via its Roadmap control algorithm.

d. Wall Mounted Unit
   1) The basis of design shall be Sanyo Model KHX.
   2) The indoor unit shall be a wall mounted fan coil unit for installation onto a wall within a conditioned space to be connected to outdoor 2-way heat pump condensing unit.
   3) Acoustic Performance:
      a) The indoor units sound pressure shall range from 28 dB(A) to 35 dB(A) at low speed measured at 3.3 feet below the unit.
   4) Construction:
      a) The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have an auto-swing louver which ensures efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge louver angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The condensate drain pipe shall be fitted to either left or right sides.
      b) Both refrigerant lines shall be insulated from the outdoor unit.
      c) The indoor units shall be equipped with a condensate pan.
      d) The indoor units shall be equipped with a return air thermistor.
   5) Unit Cabinet:
      a) The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.
      b) The cabinet shall be constructed of molded plastic cover with sound absorbing foamed polystyrene and polyethylene insulation.
   6) Fan:
      a) The fan shall be a direct-drive cross-flow fan, statically and dynamically balanced impeller with high, medium and low fan speeds available.
      b) The airflow rate shall be available in high, medium and low settings.
      c) The fan motor shall be thermally protected.
   7) Filter:
      a) The return air shall be filtered by means of a washable long-life filter with mildew proof resin.
   8) Coil:
      a) Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
      b) The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
      c) The coil shall be a 2 row cross fin copper evaporator coil with 14 fpi design completely factory tested.

d) The refrigerant connections shall be flare connections and the condensate shall be 1-1/4 inch outside diameter PVC.
e) A condensate pan shall be located in the unit.
f) A thermistor shall be located on the liquid and gas line.

9. Controls
   a. The unit shall have controls provided with the unit by the manufacturer to perform input functions necessary to operate the system.
   b. Computerized PID control shall be used to maintain room temperature within 1° F of setpoint.
   c. The unit shall be equipped with a programmed drying mechanism that dehumidifies while inhibiting changes in room temperature.
   d. The fan coil circuit board shall be wired to enable auxiliary heating when coil thermistor temperature drops below 104 degrees F in heating mode.
10. Controllers
   a. Physical Characteristics:
      1) General: The control system shall be a neutral color plastic material with a Liquid Crystal Display (LCD).
   b. Electrical Characteristics:
      1) General: From each circuit board to the controls, the electrical voltage shall be 16 volts DC.
      2) Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the outdoor unit. Control wiring shall run from the indoor unit terminal block to the specific controller for that unit.
      3) Wiring Size: The wire shall be a shielded, size AWG18-2.
11. A.C. System Remote Controller - (R410A 2-WAY VRF SYSTEM)
   a. The basis of design shall be Sanyo model SHA-KC64UG
      1) The controller shall control up to 64 units in 4 zones and shall be able to be used in conjunction with all room controller types. Collective and individual group commands are available with permit/prohibit individual remote controller function. Up to five system controllers shall be able to reside on any one S-net communication bus. The system controller shall use the following connections for power and remote monitoring:
         L1: Power supply (60 Hz, 208-230 VAC)
         C1: Inter-unit control wiring (Low voltage)
         C3: Auxiliary
         C4: Ground for inter-unit control wiring
         A1: Input for turning ON air conditioners concurrently
         A2: Input for turning OFF air conditioners concurrently
         A3: Common input for turning air conditioners ON or OFF
         B1: On operation state indicator output
         B2: Alarm indicator output
         B3: Common indicator output
12. Web Enabled Intelligent Controller - (R410A 2-WAY VRF SYSTEM) The basis of design shall be Sanyo model SHA-KT256B
   a. This controller shall be wall mounted and hard wired, either directly to the Sanyo S-net control system or via RS485 gateway using SHA-KA128A. It will be manufactured in ABS plastic with an LCD display and will be the manufacturer's standard color. The controller will be capable of individually controlling the following functions on 256 indoor fan coil units:

      On/off.
      Operating mode.
      Set point.
      Fan speed.

Louver position.
Timer settings.
Test run.

b. The controller shall also be capable of displaying the following information individually for 256 indoor fan coil units:

On/off.
Operating mode.
Set point.
Fan speed.
Louver position.
Timer settings.
Test run.
Fault diagnosis.

c. Each Intelligent controller unit can be accessed either locally or remotely via standard Internet Explorer software. The Intelligent controller will be able to indicate system alarms via volt free contacts as well as providing control points for other D0 devices

d. The intelligent controller shall be able to monitor individual tenant's usage of heating and cooling demands, report alarm and conditions to nominated email address, and enable remote alteration of systems set points to registered users. This information shall also be integrated into the central Building Automation system.

13. Building Automation System Interface Controls

a. Provide BAS system interface controls capable of performing the following functions:

Schedule Time Setting
Start/Stop, Temperature Setting, Fan Speed
Available Alarm Contact for Remote Monitoring (Condensate Pump)
Communicate with BACNet Compatible BAS System
Controls up to 64 indoor units and outdoor unit

2.25 CONDENSATE DISCHARGE PUMPS (Refer to various equipment schedules for locations and section 018100 Commissioning for additional contract requirements)

A. General: Provide where indicated, condensate pumps of capacity as scheduled, to be field installed in various air handling equipment drain pans, consisting of ABS housing, pump, check valve, safety switch, and thermal overload protection. Factory assembled unit must be UL/CSA listed.

B. High-Capacity Pumps

1. Reservoir: Construct of ABS plastic with a 3/10 capacity volume.
2. Pump: 25 GPH@15TDH vertical type pump with stainless steel motor shaft, rustproof, ABS volute, with safety switch.
3. Housing and Cover: Each shall be ABS plastic.
4. Manufacturers: Subject to compliance with requirements, provide high-capacity condensate pump of Little Giant or approved equal:

C. Low-Capacity Pumps

1. Pump: 8 GPH@33TDH reciprocating piston pump direct discharge with no storage reservoir.
2. Detection Unit: Low-maintenance filter free with a three level float (on/off/alarm).
3. Pump Housing and Detection Unit: Each shall be ABS plastic.

4. Manufacturers: Subject to compliance with requirements, provide low-capacity condensate pump of Sauermann or approved equal.

2.26 FIRESTOP SYSTEMS

A. General: Provide firestopping at all fire-rated construction where penetrated by the Work of this Section.

B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.27 WALL AND CEILING ACCESS DOORS

A. General: Furnish access panels for installation by others, at all new and existing construction where required for access to the Work of this Section. Furnish access doors for access to all concealed control valves, motor operated dampers, fire doors, etc, and all other concealed parts of the HVAC system that require accessibility for the proper operation and maintenance of the system.

B. Refer to Section 083100 - Access Doors and Frames, for all product requirements for furnishing access panels.

C. Coordinate locations and schedule with the work of trades involved with construction in which access panels will be installed.

D. Access doors shall be heavy gage steel with 1" frame. Door shall be fastened to frame with continuous piano hinge. Entire door and frame assembly shall be prime painted and be completed with cylinder lock and two (2) keys. Door and frame shall match fire rating of wall or ceiling installed into.

E. Manufacturer: Subject to compliance with requirements, provide access doors of one of the following:
1. Inland Steel Products Company, "Milcor"
2. Walsh-Hannon-Gladwin Inc., "Way Loctor"
3. Or Equal.

2.28 AUTOMATIC TEMPERATURE CONTROLS (Refer to section 018100 Commissioning for additional contract requirements)

A. Basic Components and Systems:
1. General: Provide control products in sizes and capacities indicated, consisting of dampers, thermostats, clocks, sensors, controllers, and other components as required for completed installation. Except as otherwise indicated, provide manufacturer’s standard materials and components as published in their product information, designed and constructed as recommended by manufacturer and as required for application indicated. All equipment and systems shall be installed by factory trained contractors with the following functional and construction features.

2. Electric Wiring: All electric wiring and wiring connections, either line voltage or low voltage, from the main electric panels to the ATC panels, and from the ATC related panels to the individual control devices i.e. rooftop units, exhaust fans, boilers, chillers, valves, dampers, etc. required for the installation of the control system, as herein specified shall be provided by the control contractor unless specifically shown on the electrical drawings or called for in the electrical specifications.
    a. The wiring installation shall be in accordance with National and Local Codes and with the Electrical portion of these specifications. All wiring shall be run concealed wherever possible. Exposed wiring in occupied areas shall be run in raceways. Raceways shall be Wiremold 200 series with all elbows, raceways, covers, mounting stops, box extensions and wiring for a complete and neat installation. All wiring located in mechanical spaces, boiler rooms, fan rooms, etc. shall be installed in metal conduit
    b. All wiring above ceilings, in boiler rooms, and all mechanical spaces shall follow routing of piping and where not possible shall be in conduit. All exposed wire shall be bundled and wire tied and shall be supported to adjacent piping. Draped and free floating wire will not be allowed.
    c. All terminations of wire at control devices shall be looped and supported adequately.
    d. All wiring shall comply with the requirements of the electrical section of the specification.

B. Controls Systems Wiring
1. All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor except as shown on the Electrical Trade documents. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.
2. All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.
3. The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.
4. Class 2 Wiring
    a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
    b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5ft. from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
5. Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.
6. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
    a. All circuits are continuous and free from short circuits and grounds.
    b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megaohms.
    c. All circuits are free from induced voltages.
7. Provide complete testing for all cables and wiring. Provide all equipment, tools, and personnel as necessary to conduct these tests.
8. Provide for complete grounding of all signal and communication cables, panels and equipment so as to ensure integrity of Controls Systems operation. Ground cabling and conduit at panel terminations. Do not create ground loops.

C. Line Voltage Power Sources
   1. 120-volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers as designated on the electrical drawings.
   2. Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.
   3. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.

D. Controls Systems Raceways
   1. All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification. Minimum conduit size 3/4".
   2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
   3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.
   4. UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

E. Penetrations
   1. Firestopping for all penetrations used by dedicated Controls Systems conduits and raceways shall be by other trades.
   2. All openings in fire proofed or fire stopped components shall be closed by other trades using approved fire resistive sealant.
   3. All wiring passing through penetrations, including walls, shall be in sleeves, conduit or enclosed raceway.
   4. No penetrations through building structural elements, slabs, ceilings and walls shall be made before receipt of written approval from the Architect.

F. Controls Systems Identification Standards
   1. Node Identification: All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node environmental location.
   2. Cable shall be labeled at every termination with cross-referencing to record documentation.
   3. Raceway Identification: Exposed covers to junction and pull boxes of the FMS raceways shall be identified at primary points.
   4. Wire Identification: All low and line voltage wiring shall be identified by a number, as referenced to the associated shop and record drawing, at each termination.
   5. Wires and cabling shall not be spliced between terminations. Cable shields shall be single end grounded – typically at the panel end outside the panel.
   6. Suggested color coding, for use at the Contractors option, are:
      a. Analog Input Cable — Yellow
      b. Analog Output Cable — Tan
      c. Binary Input Cable — Orange
      d. Binary Output Cable — Violet
      e. 24 VAC Cable — Gray
      f. General Purpose Cable — Natural
      g. Tier 1 Comm Cable — Purple
      h. Other Tier Comm Cable — Blue
   7. Provide permanent identification labels at all valve and damper actuators to indicate open and closed positions.

G. Field Panel And Device Installations And Locations
   1. The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
   2. All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.
   3. Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.
   4. Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.

H. Networking Communications
   1. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of multiple levels for communication efficiency, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.
   2. System shall communicate with a BACnet network over Ethernet or BACnet/IP (according to Annex J). The intent is to use the system provided under this contract to communicate with control systems and/or devices provided by other vendors. A PICS must be provided describing the BACnet, ANSI/ASHRAE 135-95, implementation. The product shall be Network Application Engine level 1 controllers with field equipment controller for level 2 controllers no substitutions. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from a common workstation.
      a. System shall have the capability to be an OPC Client and Server for dynamic communication with OPC Clients or Servers over an Ethernet network. At a minimum, the following must be supported:
         1) Data Access 1.0 (96), 1.0A (97) and 2.0 (11/98)
         2) Alarms & Events 1.0 (1/99)
   3. Peer-to-Peer Building Level 1 Network:
      a. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
      b. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations
      c. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired or dial up.
      d. The system shall support integration of third party systems (PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.
      e. Field panels must be capable of integration with open standards including Modbus, BACnet, and Lonworks as well as with third party devices via existing vendor protocols.
      f. The peer-to-peer Building Level Network shall use the TCP/IP over Ethernet. All devices must:
         1) Auto-sense 10/100 Mbps networks.
         2) Receive an IP Address from a Dynamic Host Configuration Protocol (DHCP) Server or be configured with a Fixed IP Address.

3) Resolve Name to IP Addresses for devices using a Domain Name Service (DNS) Server on the Ethernet network.
4) Allow access using Telnet.

4. Intranet/Internet access
   a. Web Based Operator Interface
      1) The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
      2) A web server computer will be supplied. The web server shall use Microsoft's IIS server 4.0 with Windows NT4, or IIS 5.0 with Windows 2000, and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).
      3) All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
      4) Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.
      5) Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
      6) The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
         a) Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.
         b) Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.
         c) Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated "web" graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.
         d) Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
         e) Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.
5. The web server licensing options will allow concurrent access by (5), (10), (25), (50), (100) browser connections.
6. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

I. DDC Controller Floor Level 2 Network
   1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.

J. DDC & HVAC Mechanical Equipment Controllers <TEC>
   1. The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.
   2. DDC & HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC & HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.
   3. DDC & HVAC Mechanical Equipment Controllers which do not meet the functions specified are not acceptable.

K. DDC Controller
   1. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.
   2. Each DDC Controller shall have 72 Megabytes of memory to support its own operating system and databases, including:
      a. Control processes
      b. Energy management applications
      c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
      d. Historical/trend data for points specified
      e. Maintenance support applications
      f. Custom processes
      g. Operator I/O
      h. Dial-up communications
      i. Manual override monitoring
   3. Each DDC Controller shall support firmware upgrades without the need to replace hardware.
   4. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
   5. DDC Controllers shall provide a RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
   6. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
      a. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
      b. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

7. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
8. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
9. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
    a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
    b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
    c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
    d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
    e. Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
        1) IEEE Standard 587-1980
        2) UL 864 Supply Line Transients
        3) Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
10. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.
    a. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
    b. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
11. Provide a separate DDC Controller for each AHU or other HVAC system as indicated in Section 3.02. It is intended that each unique system be provided with its own point resident DDC Controller.

L. HVAC Mechanical Equipment Controllers
1. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
2. Each HVAC Mechanical Controller shall have 72 Megabytes of memory to support its own operating system and databases, including:
    a. Control processes
    b. Energy management applications
    c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
    d. Historical/trend data for points specified
    e. Maintenance support applications
    f. Custom processes
    g. Operator I/O
    h. Remote communications
3. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.

4. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
5. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
6. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
    a. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
    b. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.

M. DDC & HVAC Mechanical Equipment Controller Resident Software Features
1. General:
    a. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
    b. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
    c. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).
2. Control Software Description:
    a. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
        1) Two-position control
        2) Proportional control
        3) Proportional plus integral control
        4) Proportional, integral, plus derivative control
        5) Automatic tuning of control loops
3. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
    a. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
        1) The SSTO program shall operate in both the heating and cooling seasons.
            a) It shall be possible to apply the SSTO program to individual fan systems.
            b) The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
        2) The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
    b. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
        1) It shall be possible to individually command a point or group of points.

2) For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
3) The operator shall be able to define the following information:
   a) Time, day
   b) Commands such as on, off, auto, and so forth.
   c) Time delays between successive commands.
   d) There shall be provisions for manual overriding of each schedule by an appropriate operator.
4) It shall be possible to schedule events up to one year in advance.
   a) Scheduling shall be calendar based.
   b) Holidays shall allow for different schedules.
   c) Enthalpy switchover (economizer) .The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
   d) Temperature-compensated duty cycling.
      1. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
      2. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
   e) Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
   f) Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
   g) The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
      1. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
      2. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
      3. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
      4. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.

4. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
   a. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.
   b. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

c. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
d. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.

5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
   a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
   b. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
   c. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
   d. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
   e. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
6. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
   a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a sufficient number of data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
   b. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
      1) Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
7. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.

8. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
9. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

N. Floor Level Network Application Specific Controllers (FEC)
1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (FECs) through Floor Level LAN Device Networks.
2. Each FEC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each FEC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each FEC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
3. Terminal Equipment Controllers:
   a. Provide for control of each piece of equipment, including, but not limited to, the following:
      1) VAV Terminal Boxes
      2) Fan Coil Units
      3) Heating Coils
      4) Fin Tube Radiation
      5) Convectors
      6) Radiant Heating Panels
      7) Unit Heaters, Cabinet Unit Heaters
   b. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.
   c. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable

O. Local User Display

Where specified in the sequence of operation or points list, the controllers on the peer to peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.
1. The display shall use the same security password and access rights for points in the display as is used in the associated controller.
2. The LCD display shall be a minimum of a 2 line 40 character display.
3. The LCD display shall include the full point name, value (numeric, digital or state text),

4. Point priority and alarm status on one screen.
5. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.
6. The display shall be mounted either on the door of the enclosure or remote from the controller.

P. Personal Computer Operator Workstation Hardware
1. Personal computer operator workstations shall be provided for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
   a. Provide workstation(s) of equal capability located at room indicated on drawings.
   b. Workstation shall consist of a personal computer with minimum 8.0GB RAM, hard drive with 500 GB available space, video card capable of supporting 1024 × 768 resolution with a minimum of 16 Bit color (Windows 7), DVD-ROM Drive, mouse and 101-key enhanced keyboard. Personal computer shall be a Windows 7 Compatible PC and shall include a minimum dual 1.33 Ghz Pentium processor.
   c. The PC monitor shall support a minimum display resolution of no less than 1024 X 768 pixels and shall be minimum 19". Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
   d. Also provide separate file server with available storage capacity to accommodate trending 15 min. interval of each control point for a period of (1) year for data archives.
2. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.
3. Intranet/Internet access
   a. Web Based Operator Interface
      1) The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
      2) A web server computer will be supplied. The web server shall use Microsoft's IIS server 6.0 with Windows 2008, and support browser access via Microsoft Internet Explorer 5.0 (or higher), or Navigator Netscape 6.0 (or higher).
      3) All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
      4) Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.
      5) Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
      6) The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
         a) Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.

b) Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.

c) Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated "web" graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.

d) Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.

e) Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.

7) The web server licensing options will allow concurrent access by a minimum of 10 browser connections.

8) Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

Q. Workstation Operator Interface

1. Basic Interface Description

a. Operator workstation interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with existing system and share data between the dedicated, modem autodial, and Ethernet-connected building level networks. The software shall provide, as a minimum, the following functionality:

1) Real-time graphical viewing and control of the BAS environment
2) Reporting
3) Scheduling and override of building operations
4) Collection and analysis of historical data
5) Point database editing, storage and downloading of controller databases.
6) Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
7) Alarm reporting, routing, messaging, and acknowledgment
8) "Collapsible tree," dynamic system architecture diagram application:
   a) Showing the real-time status and definition details of all workstations and devices on a management level network
   b) Showing the real-time status and definition details of all DDC and HVAC Mechanical Controllers at the building level
   c) Showing the status and definition details of all field-level application controllers
9) Definition and construction of dynamic color graphic displays.

10) Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
11) On-screen access to User Documentation, via online help or PDF-format electronic file.
12) Automatic database backup at the workstation for database changes initiated at DDC Controller operator interface terminals.

b. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a “drag and drop” approach to inter-application navigation. Selection of applications within the workstation software shall be via a graphical toolbar menu – the application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated by the user.

c. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows XP, 2000 or NT 32 bit operating system. System database parameters shall be stored within an object-oriented database, which is compliant with the Open Database Connectivity (ODBC) or Structured Query Language (SQL) standards. Standard Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information
    1) Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):
        a) Dynamic color graphics application
        b) Alarm management application
        c) Scheduling application
        d) Dynamic trend graph data plotter application
        e) Dynamic system architecture diagram application
        f) Control Program and Point database editing applications
        g) Reporting applications
    2) Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.

d. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users’ workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BAS workstation application. And each BAS workstation user account shall use a Windows 2000/NT user account as a foundation.

e. Dynamic Color Graphics application shall include the following:
    1) Must include graphic editing and modifying capabilities
    2) A library of standard control application graphics and symbols must be included
    3) Must be able to command points directly off graphics application

4) Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks.
5) Navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure
6) Graphics viewing shall include zoom capabilities
7) Graphics shall automatically display the HAND status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
8) Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.

f. Reports shall be generated on demand or via pre-defined schedule, and directed to monitor displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:
1) A general listing of all or selected points in the network
2) List of all points currently in alarm
3) List of all points currently in override status
4) List of all disabled points
5) List of all points currently locked out
6) List of user accounts and access levels
7) List all weekly schedules and events
8) List of holiday programming
9) List of control limits and deadbands
10) Custom reports from 3rd party software
11) System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
12) List of programs
13) List of point definitions
14) List of logical point groups
15) List of alarm strategy definitions
16) List of DDC Control panels
17) Point totalization report
18) Point Trend data listings
19) Initial Values report
20) User activity report

g. Scheduling and override
Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line -- PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:
1) Weekly schedules
2) Zone schedules
3) Event schedules – an event consists of logical combinations of equipment and/or zones
4) Report schedules
5) Ability to schedule for a minimum of up to 365 days in advance
Additionally, the scheduling application shall:
a) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)

b) Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
c) Provide searching capabilities of schedules based on name – with wildcarding options

h. Collection and Analysis of Historical Data
1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
2) Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.

i. The ATC contractor shall provide an additional 40 hours of ATC/BMS system programming time to assist the owner with customized programming of the ATC/BMS system.

2. Dynamic Color Graphic Displays
a. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition.
b. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.
c. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
1) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the workstation software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed.
2) Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.

3) Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
4) Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.
5) State text for digital points can be user-defined up to eight characters.

d. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
e. Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
f. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
g. Off the shelf graphic software, html web-based graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.
h. A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of 700 graphic background templates shall be provided.
i. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.

3. System Configuration & Definition
a. A "Collapsible tree," dynamic system architecture diagram/display application of the site-specific BAS architecture showing status of controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, DDC Controllers or HVAC Mechanical Equipment controllers, as well as 3rd-party integrated components. Symbols/Icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing 3rd-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics of dial-up modems to DDC Controllers.
b. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
c. Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the user-interface of DDC Controllers or HVAC Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
d. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations.

e. Point database configuration shall be available to the user within a dedicated point database editor application included in the workstation software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database. The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the DDC Controllers.
   1) The workstation software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.

4. Alarm Management
   a. Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.
   b. Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.
   c. Alarm Display shall have the ability to list & sort the alarms based on alarm status, point name, ascending or descending alarm time.
   d. Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.
   e. Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm.
   f. Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs.
   g. Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BAS system management.
   h. Remote notification of messages
      1) Workstation shall be configured to send out messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
      2) There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
      3) On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
      4) Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.
      5) System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.

6) Message detail shall be configurable on a per user basis.
7) During a “flood” of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.
8) Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
9) Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

R. Field Devices
1. Provide instrumentation as required for monitoring, control or optimization functions.
2. Room Temperature Sensors
a. Office areas shall be provided with digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Classroom and teaching room areas shall have day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Public areas such as corridors, entry areas, vestibules, restrooms shall have chrome cover plate without adjustment or occupied/unoccupied capability. Temperature sensors located in gymnasiums and locker rooms shall be provided with tamper proof guard. All temperature sensors shall be BACnet compatable network type.

Temperature monitoring range	+20/120°F -13° to 49°C)
Output signal	Changing resistance
Accuracy at Calibration point	±0.5°F (+/- 0.3°C)
Set Point and Display Range	55° to 95° F (13° to 35°C)

b. Liquid immersion temperature:

Temperature monitoring range	+30/250°F (-1°/121°C)
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F (+/-0.3°C)

c. Duct (single point) temperature:

Temperature monitoring range	+20/120°F (-7°/49°C)
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F (+/-0.3°C)

d. Duct Average temperature:

Temperature monitoring range	+20° +120°F(-7°/+49°C)
Output signal	4 – 20 mA DC
Accuracy at Calibration point	+0.5°F (+03°C)
Sensor Probe Length	25’ L (7.3m)

e. Outside air temperature:

Temperature monitoring range	-58°+122° F(-50ºC to +50ºC)
Output signal	4 – 20 mA DC
Accuracy at Calibration point	+0.5°F (+/-0.3°C)

3. Liquid Differential Pressure Transmitter

Ranges	0-5/30 inches H20 0-25/150 inches H20 0-125/750 inches H20
Output	4 – 20 mA DC
Calibration Adjustments	Zero and span
Accuracy	+-0.2% of span
Linearity	+-0.1% of span
Hysteresis	+-0.05% of span

4. Differential pressure:
   a. Unit for fluid flow proof shall be Penn P74.

Range	8 to 70 psi
Differential	3 psi
Maximum differential pressure	200 psi
Maximum pressure	325 psi

   b. Unit for air flow settings.

Set point ranges:	0.5” WG to 1.0” WG	(124.4 to 248.8 Pa)
	1.0” WG to 12.0” WG	(248.8 to 497.6 Pa)

5. Static pressure sensor:

Range	0 to .5” WG (0 to 124.4 Pa) 0 to 1” WG (0 to 248.8 Pa) 0 to 2” WG (0 to 497.7 Pa) 0 to 5” WG (0 to 1.2 kPa 0 to 10” WG (0 to 2.5 kPa)
Output Signal	4 – 20 mA VDC
Combined static error	0.5% full range
Operating Temperature	-40º to 175º F (-40C to 79.5ºC)

6. Air Pressure Sensor:

Range:	0 to 0.1 in. water (0 to 24.9 Pa) 0 to 0.25 in. water (0 to 63.2 Pa) 0 to 0.5 in. water (0 to 124.5 Pa) 0 to 1.0 in. water (o to 249 Pa) 0 to 2.0 in water 90 to 498 Pa) 0 to 5.0 in. water (0 to 1.25 kPa) 0 to 10.0 in.water (0 to 2.49 kPa)
Output signal	4 to 20 mA
Accuracy	+1.0% of full scale

Humidity Sensors: All room/zone humidity sensors shall be BACnet compatible network type.

Range	0 to 100% RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC
Accuracy	At 77°F(25ºC) + 2% RH

Humidistat:

Range	0 to 100% RH
Sensing Element	Bulk Polymer
Output Signal	4 – 20 mA DC
Accuracy	At 77°F(25ºC) + 2% RH

7. Insertion Flow Meters (Equal to Onicon Series F-1200)

Sensing Method	Impedance Sensing
Accuracy	+ 2% of Actual Reading
Maximum Operating Pressure	400 PSI
Output Signal	4 – 20 mA

Bi-directional where required.

8. Pressure to Current Transducer

Range	3 to 15 psig (21 to 103 kPa) or 3 to 30 psig (21 to 207 kPa)
Output signal	4 – 20 mA
Accuracy	+ 1% of full scale (+ 0.3 psig)

9. Carbon Dioxide Sensor : All room/zone CO_2 sensors shall be BACnet compatible network type and shall have a minimum 5 year calibration period.

Range	0 to 1500 ppm
Accuracy	20+ ppm

CO2 sensors located in gymnasiums and locker rooms shall be provided with tamper proof guard.

10. Control Valves (all control valves shall have electric actuators).
    a. Electric Control

Rangeability	40:1
Flow Characteristics	Modified. Equal percentage
Control Action	Normal open or closed as selected
Medium	Steam, water, glycol
Body Type	Screwed ends 2” and smaller, flanged Valves 2½” and larger
Body Material	Bronze
Body Trim	Bronze
Stem	Stainless Steel
Actuator	0-10 VDC, 4-20 MA or 2 position 24 VAC/120VAC

    b. All automatic temperature control valves in water lines shall be provided with Characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.
        1) Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing.
        2) Two position valves shall be line size.

11. Damper Actuators
    a. Electric control shall be direct coupled actuators.

b. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
   1) The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½" diameter shaft or damper blade.
c. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.
d. All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.
e. All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.
f. All actuators shall be designed and manufactured by Johnson Inc. or approved equal using ISO900 registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 l.

S. Miscellaneous Devices
1. Thermostats (Stand-alone electric type - only where specified or indicated on drawings)
   a. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
   b. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
   c. Thermostats shall be arranged for either horizontal or vertical mounting.
   d. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
   e. Mount the thermostat covers with tamper-proof socket head screws.
2. Freezestats:
   a. Install freezestats on each coil that mixes outside and return air (air handling units, fan coils, unit ventilators, etc.) and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
      1) Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position close outside air dampers and open coil valve for full flow. Provide manual reset.
3. Firestats:
   a. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
      1) Switch shall have adequate rating for required load.
4. Electronic Airflow Measurement Stations and Transmitters (Where indicated on Control Drawings).
   a. Provide air flow moving stations as shown on drawings.
   b. Stations – each insertion station shall contain an array of velocity sensing elements and straightening vanes. The velocity sensing elements shall be of the RTD or thermistor type. The sensing elements shall be distributed across the duct cross section in a quality to provide accurate readings. The resistance to airflow through the airflow measurement station shall not exceed 0.08 inches water gage at an airflow of 2,000 fpm. Station construction shall be suitable for operation at airflow of up to 5,000 fpm over a temperature range of 40 to 120 degrees F, and accuracy shall be plus or minus 3 percent over a range of 125 to 2,500 fpm scaled to air volume. Each transmitter shall produce a linear, temperature compensated 4 to 40 mA DC, output corresponding to the required velocity pressure measurement. Provide local readout on unit.

c. Fan inlet airflow sensing
   1) Where mounted into controllable pitch axial inlet bells, or inlet cones of centrifugal fans, the traverse probe assemblies shall be complete with all necessary end mounting plates and master takeoff fittings. All mounting bolts, lock washers and nuts; interconnecting tubing and compression fittings to be provided by the installing contractor.
   2) Primary flow elements shall not be used on fan inlet applications where the narrowest diameter of the inlet cone is under ten inches without prior approval. Fan inlet sensors shall not be used on fans having inlet guide vanes. The use of only one static element and one total pressure element on fan inlets is prohibited. Fan primary elements shall not exceed .562 inches in diameter on fans having inlet cone diameters less than 30-inches.
   3) Fan inlet airflow sensing similar to Ebtron GTx116F or Paragon Controls model FE-1050.

d. Electronic Transducers
   1) Provide individual differential static pressure and airflow transducers, selected for the required range of each of the above primary elements, and in accordance with the following:
   2) The transducer(s) shall be solid-state electronic type, with infinite output resolution, capable of performing dedicated static pressure and air volume control functions. Microprocessor based transducers with time-sharing of multiple square root extractors and/or controllers are not acceptable.
   3) Each transducer's output shall not be affected by direction of mounting (attitude) or external vibrations, and shall be furnished with a factory-calibrated range that matches the application.
   4) Airflow transducers shall be provided with an integral dual scale indicating meter operating independent of all other control devices. The top scale shall indicate the measured air volume in units of cubic feet per minute (CFM), and the bottom scale shall indicate the air velocity in units of feet per minute (FPM).
      a) The meter shall be a differential pressure type that is diaphragm actuated, and is to be flush mounted on the enclosure door.
      b) The meter shall be calibrated to an accuracy of +2% of span.
         1) Transducer performance shall be equal to or better than the following:
            a) Accuracy: +/- 0.5% F.S. (Terminal Point) / +/- 0.35% F.S. (BFSL)
            b) Temperature Effects: <0.03% F.S./deg F
            c) Over-pressure: 5 PSIG Proof / 10 PSIG Burst
            d) Response: <0.25 seconds for full scale input
            e) Noise Filtration: Low Pass Filter, factory set @ 3.2Hz
         2) Each transducer shall be selected for its respective duty. Supply, Exhaust and/or Return Airflow Transducers shall provide analog output signal linear to air volume that are factory set for a full scale value equal to 110% of the maximum design capacity of the flow measuring element served for variable air volume applications, or 200% of the design operating value for constant volume applications.
         3) Airflow transducers for operating velocities below 1266 feet per minute shall provide the following features:
      c) Local electronic indication of the measure airflow rate.
         1) The indicating meter shall be one-half inch high, three and one half digit light emitting diode (LED) type.
      d) The LED shall indicate the measured air volume in engineering units of cubic feet per minute (CFM).

e) Automatic zeroing circuit that shall maintain the transducer output to within 0.1% of value, and shall be field configurable for frequency of activation between one and seventy two hours.
f) The transducer output shall be locked and maintained at the last given output value during the automatic zeroing period so as not to interrupt the automatic control process.
g) The meter shall be auto calibrated to an accuracy of +/- 1 count.
1) Transducer accuracy shall be +/- 0.25% F.S. (Terminal Point) / +/- 0.15% F.S. (BFSL)

5. Current Sensing Relay:
a. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
b. Adjust the relay switch point so that the relay responds to motor operation under load as an “on” state and so that the relay responds to an unloaded running motor as an “off” state. A motor with a broken belt is considered an unloaded motor.
c. Provide for status device for all fans and pumps.

T. Manufacturers: Subject to compliance with requirements, provide automatic temperature controls of one of the following:
1. Honeywell
2. Delta
3. Johnson Controls
4. Allerton Controls
5. Or Equal.

PART 3 - EXECUTION

3.1 DEMOLITION

A. Demolition of Existing Mechanical Work:
1. Disconnect all existing materials, fixtures and equipment indicated to be salvaged.
2. Disconnect and cap all existing mechanical lines from building as indicated on drawings.
3. Notify General Contractor when existing fixtures, materials, equipment and other features are ready for removal, salvaging, and disposal under Section 024119 - Demolition.
4. Demolition work shall occur in accordance with phasing schedule as indicated on architectural phasing plans.

3.2 CUTTING AND PATCHING

A. Penetrations through construction as required for the Work of this Section:
1. Coring: Perform all coring for required work.
2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – Unit Masonry, utilizing lintels furnished per Section 055000 – Metal Fabrications.
3. Cut openings in new and existing non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 017329 – Cutting and Patching, and 024119 – Demolition.
4. Refer to Section 024119 – Demolition for restrictions on all alterations to structural elements.

B. Patching at penetrations through construction as required for the Work of this Section:
   1. Notify Masonry Sub-Contractor when plumbing work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – Unit Masonry.
   2. Notify appropriate Sub-Contractors when plumbing work is complete at penetrations through non-masonry construction, and ready for patching under Sections in Division 9 - FINISHES.

3.3 INSTALLATION OF VALVES

A. Examine valve interior through the end ports, for cleanliness, freedom from foreign matter and corrosion. Remove special packing materials, such as blocks used which prevents disc movement during shipping and handling.

B. Actuate valve through an open-close and close-open cycle. Examine functionally significant features, such as guides and seats made accessible by such actuation. Following examination, return the valve closure member to the position in which it was shipped.

C. Examine threads on both the valve and the mating pipe for form (out-of-round or local indentation) and cleanliness.

D. Examine mating flange faces for conditions which might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size and material, and for freedom from defects and damage.

E. Prior to valve installation, examine the piping for cleanliness, freedom from foreign materials, and proper alignment.

F. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:
   1. Copper Tube 2" and smaller (Heating Hot Water): Solder ends.
   2. Steel Pipe Sizes 2" and smaller: Threaded or grooved-end.
   3. Steel Pipes Sizes 2-1/2" and larger: Grooved-end or welded.

G. Valve Installation
   1. Locate valves for easy access and provide separate support where necessary.
   2. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shut-down. Unions are not required on flanged devices.
   3. Install valves in horizontal piping with the stem at or above the center of the pipe.
   4. Install isolation valves at all branch supply and return piping lines which serve more than two pieces of terminal heating equipment.
   5. Installation of Check Valves: Install for proper direction of flow as follows:
      a. Swing Check Valves: Install in horizontal position with hinge pin level.
      b. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position.
      c. Lift Check Valves: Install in piping line with stem upright and plumb.

H. Threaded Connections
   1. Note the internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
   2. Align threads at point of assembly.
   3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

I. Flanged Connections
1. Align flanges surfaces parallel.
2. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using a torque wrench.

J. Grooved Connections
1. Installation shall be in accordance with the latest published instructions from the manufacturer.

K. Field Quality Control
1. Testing: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

L. Adjusting and Cleaning
1. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive painting or insulation.

3.4 INSTALLATION OF METERS AND GAGES

A. Installation of Temperature Gages
1. General: Install temperature gages in vertical upright position, and tilted so as to be easily read by observer standing on floor.
2. Temperature Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure Cap.

B. Installation of Pressure Gages
1. General: Install pressure gages in piping tee with pressure gage located on pipe at most readable position.
2. Pressure Gage Cocks: Install in piping tee with snubber. Install siphon for steam pressure gages.
3. Pressure Gage Connector Plugs: Install in piping tee where indicated, located on pipe at most readable position. Secure cap.

C. Installation of Flow Measuring Fittings
1. General: Install flow measure fittings in piping systems located in accessible locations.

D. Adjusting and Cleaning
1. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
2. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows; repair any scratched or marred surfaces with manufacturer's touch-up paint.

3.5 INSTALLATION OF HANGERS & ATTACHMENTS

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

C. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.

D. Prior to installation of hangers, supports, anchors, and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purposes of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

E. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.

F. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
   1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
   2. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
   3. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
   4. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
   5. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
   6. Insulated Piping: Comply with the following installation requirements:
      a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.

b. Shields: For pipe sizes up to and including 4” provide heavy gage shield at each hanger point.
c. Saddles: For all pipe sizes over 4” provide saddle at each hanger point. Completely fill void in saddle with loose insulation.

G. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer for loading and stresses to connected equipment.

H. Fabricate and install anchor by welding steel shapes, plates, and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

I. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.

J. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

K. Provide concrete housekeeping bases for all floor-mounted equipment. Size bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.

L. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

M. Adjusting and Cleaning:
1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.6 INSTALLATION OF MECHANICAL IDENTIFICATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces; install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. General: Install pipe markers of the following type on each system indicated to receive identification, and include arrows to show normal direction of flow:
1. Plastic pipe markers, with application system as indicated. Install on pipe insulation segment where required for hot non-insulated pipes.

C. Locate pipe markers and color bands as follows wherever piping is in or above occupied spaces or corridors, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.

3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above removable acoustical ceilings.

D. Valve Identification:
1. General: Provide valve tag on every valve, cock, and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.
2. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

E. Mechanical Equipment Identification:
1. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device.
2. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2' - 0", 1/2" high for distances up to 6' - 0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

F. Adjusting and Cleaning:
1. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
2. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.7 INSTALLATION OF MECHANICAL INSULATION

A. Installation of Piping Insulation:

1. Insulation Omitted: Omit insulation on hot piping within radiation enclosures which serve the zone: hot water passing through the zone must be insulated or unit cabinets; on cold piping within unit cabinets provided piping is located over drain pan. (Couplings in mechanical grooved systems will be insulated.)
2. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.
3. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance tests.
4. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
5. Clean and dry pipe surfaces prior to insulating. Butt installation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
6. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

7. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated. Do not cover calibrated balance valves until testing adjusting and balancing has been completed.
8. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
9. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

B. Installation of Ductwork Insulation:
1. General: Do not insulate ductwork until ductwork has been sealed successfully, pressure tested, and approved for application of insulation by engineer or commissioning agent. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its indented purpose.
2. Install insulation materials with smooth and even surfaces.
3. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
5. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
6. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

C. Installation of Equipment Insulation:
1. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.
2. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.
3. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.
4. Do not apply insulation to equipment, breechings, or stacks while hot.
5. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.
6. Coat insulated surfaces with layers of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.
7. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.
8. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruption of insulation.
9. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

D. Protection and Replacement:
1. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

2. Protection; Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.8 INSTALLATION OF HYDRONIC PIPING AND ACCESSORIES

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Piping Installations:
1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design consideration. So far as practical, install piping as indicated.
2. Install piping at a uniform grade of 1" in 40' upward in the direction of flow.
3. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
4. Install branch connections to mains using Tee fittings in main with take-off out the bottom, except for up-freed risers which shall have take-off out the top of the main line.
5. Install unions in pipes 2" and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
6. Install flanges on valves, apparatus, and equipment having 2-1/2" and larger connections.
7. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2" and larger.
8. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings.
9. Install pipe sleeves at all wall and floor penetrations.
10. Install escutcheons at all exposed pipe wall penetrations.
11. Provide Dielectric couplings at all dissimilar piping/valve connections.

C. Pipe Applications:

1. Copper Tubing: Use Type L, drawn copper tubing with wrought copper fittings and solder joints for 2" and smaller, above ground, within building. Use Type K, annealed temper copper tubing for 2" and smaller without joints, below ground or within slabs. Mechanical fittings (crimp or flair) are not permitted.
2. Steel Pipe: Use steel pipe with threaded joints and fittings for 2" and smaller, and with welded joints for 2-1/2" and larger.
3. Steel Pipe: Use mechanical grooved end steel pipe and mechanical couplings and fittings.

D. Grooved Ends:
1. Roll Groove pipe ends in accordance with the latest published instructions from manufacturer of grooved couplings.

E. Valve Applications:
1. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
   a. Shut-Off Duty: Use gate, and ball, valves.
   b. Throttling Duty: Use globe, ball, and plug valves.

2. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
3. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
4. Install safety relief valve on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.
5. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.
6. Install isolation valves in all branch supply take-offs from piping mains which serve more than two terminal heating or cooling units. Provide balancing valve with positive shut off in all return branch take-offs which serve more than two terminal heating or cooling units. Provide isolation valves in floor supply main piping lines and balancing valves with positive shut-off in all floor return main piping take-offs.

F. Hydronic Specialties Installation:
1. Install automatic air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting. Install air vents with cocks such that vents can be removed without draining system.
2. Install combination separator/strainer in pump suction lines. Run piping to compression tank with 1/4" per foot (2%) upward slope towards tank. Install blowdown piping with gate valve; extend to nearest drain.
3. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
4. Install shot-type chemical feeders in each hydronic system; in upright position with top of funnel not more than 48" above floor. Install feeder in bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
5. Install diaphragm-type compression tanks as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.
    a. In the absence of details provide support from the floor or structure above sufficient for the weight of water assuming a full tank of water. Do not overload building components and structural members.

G. Field Quality Control:
1. Preparation for Testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
    a. Leave joints including welds uninsulated and exposed for examination during the test.
    b. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
    c. Flush system with clean water. Clean strainers.
    d. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
    e. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
2. Testing: Test hydronic piping as follows:
    a. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

b. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at point for complete removal of the liquid.
c. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
d. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
e. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connection for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

H. Adjusting and Cleaning:
1. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
2. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.9 INSTALLATION OF REFRIGERANT PIPING AND ACCESSORIES

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Piping Installations:
1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, and other design consideration. So far as practical, install piping as indicated.
2. Install pipe sleeves at all wall and floor penetrations.
3. Install escutcheons at all exposed pipe wall penetrations.

3.10 INSTALLATION OF ROOFTOP PENTHOUSE ENCLOSURES

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.

C. Support: Contractor shall coordinate installation with the roofing contractor, and shall install and secure roof curb to roof structure, per details on the drawings and in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

D. Access: Provide access space around units for service as indicated, but in no case less than that recommended by manufacturer.

3.11 INSTALLATION OF CONDENSING BOILERS

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and Local Code requirements. Install units plumb and level, to tolerance of 1/8" in 10' - 0" in both directions. Maintain manufacturer's recommended clearances around and over boilers.

C. Support: Install boilers on 4" thick concrete pad, 4" larger on each side than base of unit. Provide supplemental structural steel supports (minimum 8" high) to elevate boiler as required to allow proper condensate drainage.

D. Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
   1. Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment Installer.

E. Gas Piping: Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.

F. Hot Water Piping: Connect supply and return boiler tappings as indicated, with shutoff valve and union or flange at each connection.

G. Regulator Vents: Provide ¾” vent from each main and pilot regulator. Each vent shall terminate outdoors per code requirements.

H. Breeching: Connect breeching to boiler outlet, full size of outlet. Route as indicated. Coordinate breeching routing and sizing with Boiler Manufacturer and vent system manufacturer.

I. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

J. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

K. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boiler piping, observation of hydrostatic testing, and for certification of completed boiler units.

L. Start-up boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's start up representative. Test controls, and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

M. Owner's Instructions: Provide services of manufacturer's technical representative for 4-hour day to instruct Owner's personnel in operation and maintenance of boilers.
   1. Schedule training with Owner, provide at least 7-day notice to Contractor and Engineer of training date.

3.12 INSTALLATION OF HVAC PUMPS

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that HVAC pumps comply with requirements and serve intended purposes.

C. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.

D. Support: Install base-mounted pump assembly on minimum of 4" high concrete base equal or greater than 3 times total weight of pump and motor. Set and level pump in base and grout with non-shrink grout.

E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
   1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

F. Adjusting and Cleaning
   1. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
   2. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
   3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.13 INSTALLATION OF HVAC ROOFTOP UNITS (RTU)

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.

C. Support: Contractor shall coordinate installation with the roofing contractor, and shall install and secure roof curb to roof structure, per details on the drawings and in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

D. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

E. Duct Connections: Provide ductwork, accessories, and flexible connections as indicated.

F. Grounding: Provide positive equipment ground for air-handling unit components.

G. Provide two complete extra sets of filters for each air handling unit. Install new filters at completion of air handling system work, and after completion of testing, adjusting, and balancing work in accordance with MA-CHPs requirements. Obtain receipt from Owner that new filters have been installed.

H. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

I. Electrical Connections: Refer to electrical sections for final connections to equipment and installation of loose shipped electrical components.

J. Start-Up Services:
1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

K. Operating and Maintenance Training:
1. Provide services of manufacturer's service representative (minimum 8 hrs.) to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance.
2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

3.14 INSTALLATION OF H & V ROOFTOP UNITS (HVU)

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in location indicated, and maintain manufacturer's recommended clearances.

C. Support: Contractor shall coordinate installation with the roofing contractor and shall install and secure roof curb to roof structure, per details on the drawings and in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

D. Access: Provide access space around air handling units for service as indicated, but in no case less than that recommended by manufacturer.

E. Duct Connections: Provide ductwork, accessories, and flexible connections as indicated.

F. Grounding: Provide positive equipment ground for air-handling unit components.

G. Provide two complete extra sets of filters for each air handling unit. Install new filters at completion of air handling system work, and after completion of testing, adjusting, and balancing work in accordance with MA-CHPs requirements. Obtain receipt from Owner that new filters have been installed.

H. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

I. Electrical Connections: Refer to electrical sections for final connections to equipment and installation of loose shipped electrical components.

J. Start-Up Services:
1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

K. Operating and Maintenance Training:
1. Provide services of manufacturer's service representative (minimum 4 hrs.) to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance.
2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

3.15 INSTALLATION OF VARIABLE AIR VOLUME BOXES

A. Vibration Control And Seismic Restraint: Refer to section 15100 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 15100 and drawing VS-1.

B. General: Install variable air volume boxes as indicated, and in accordance with manufacturer's installation instructions.

C. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

3.16 INSTALLATION OF GAS FIRED MAKE-UP AIR UNITS (MAU)

A. Vibration Control and Seismic Restraint: Refer to section 23 05 48 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install units where indicated, in accordance with equipment manufacturer's published installation instructions, and with recognized industry practices, to ensure that units comply with requirements and serve intended purposes.

C. Coordination: Coordinate with other work, including ductwork, floor construction, roof decking, and piping, as necessary to interface installation of units with other work.

D. Access: Provide access space around units for service as indicated, but in no case less than that recommended by manufacturer.

E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
   1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 00 00 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

F. Duct Connections: Provide ductwork, accessories, and flexible connections as indicated.

G. Grounding: Provide positive equipment ground for unit components.

H. Testing: Upon completion of installation of units, start-up and operate equipment to demonstrate capability and compliance with requirements. Field correct malfunctioning units, than retest to demonstrate compliance.

I. Provide two complete extra set of filters for each unit. Install new filters at completion of system work, and again after completion of testing, adjusting, and balancing work in accordance with MA-CHPs requirements. Provide spare set of filters. Obtain receipt from Owner that new filters have been installed.

J. Provide one spare set of belts for each belt-driven unit, obtain receipt from Owner that belts have been received. Provide one spare set of belts for each belt-driven air handling unit, obtain receipt from Owner that belts have been received.

K. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

L. Operating and Maintenance Training:
   1. Provide services of manufacturer's service representative (2 hours minimum) to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance.
   2. Schedule training with Owner, provide at least 7-day prior notice to the Architect/Engineer.

3.17 INSTALLATION OF TERMINAL HEATING UNITS (HYDRONIC)

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Installation of Finned Tube Radiation: (Hydronic)
1. General: Install finned tube radiation as indicated, and in accordance with manufacturer's installation instructions.
2. Locate finned tube radiation as indicated, run cover wall-to-wall unless otherwise indicated. Provide butt caps, splice joints, "Z" bends etc. for a complete installation.
3. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.

C. Installation of Convectors: (Hydronic)
1. General: Install convectors as indicated, and in accordance with manufacturer's installation instructions.
2. Locate convectors as indicated, coordinate with other trades to assure correct recess size for recessed convectors.

D. Installation of Horizontal Unit Heaters: (Hydronic)
1. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
2. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
3. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
4. Support units with rod-type hangers anchored to building substrate.
5. Install piping as indicated.
6. Protect units with protective covers during balance of construction.

E. Installation of Cabinet Unit Heaters: (Hydronic)
1. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
2. Coordinate with other trades to assure correct recess size for recessed units.
3. Install piping as indicated.
4. Protect units with protective covers during balance of construction.

F. Installation of Coils: (Hydronic)
1. General: Install coils as indicated, and in accordance with manufacturer's installation instructions.
2. Pitch coil casings for drainage, not less than 1/8" toward return connections, except where drainage feature is included in coil design.

G. Adjusting and Cleaning:
1. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
2. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
3. Install new filter units for terminals requiring same.

3.18 INSTALLATION OF TERMINAL HEATING UNITS (ELECTRIC)

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. Installation of Electric Heating Terminals:
   1. Install electric heating terminal units including components as indicated, in accordance with equipment manufacturer's written instructions, and with recognized industry practices; complying with applicable installation requirements of NEC and NECA's "Standard of Installation".
   2. Coordinate with other electrical work, including wiring/cabling, as necessary to properly interface installation of heating terminal units with other work.
   3. Clean dust and debris from each heating terminal as it is installed to ensure cleanliness.
   4. Comb out damaged fins where bent or crushed before covering elements with enclosures.
   5. Touch-up scratched or marred heating terminal enclosure surfaces to match original finishes.
   6. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminal to comply with tightening torques specified in UL Std. 486A.

C. Grounding:
   1. Provide equipment grounding connections for electric heating terminals as indicated, Tighten connections to comply with tightening torque values specified in UL std. 486A to assure permanent and effective grounding.

D. Electrical Wiring:
   1. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.
      a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
      b. Upon completion of installation of electric heating terminals, and after building circuitry has been energized, test heating terminals to demonstrate capability and compliance with requirements. Where possible, field correct malfunctioning units, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting.
      c. Replace electric heating terminals and accessories which are damaged and remove damaged items from construction site.

E. Adjusting and Cleaning:
   1. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets.
   2. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
   3. Install new filter units for terminals requiring same.

3.19 POWER AND GRAVITY VENTILATORS

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that products serve the intended function.

C. Coordinate ventilator work with work of roofing, walls and ceilings, as necessary for proper interfacing.

D. Ductwork: Connect ducts to ventilators in accordance with manufacturer's installation instruction, and details on drawings.

E. Roof Curbs: Furnish roof curbs to roofing Installer for installation.

F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
   1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

G. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.

H. Testing: After installation of ventilators has been completed, test each ventilator to possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

I. Cleaning: Clean factory-finished surface. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

J. General: Furnish to Owner, with receipt, one spare set of belts for each belt driven power ventilator.

3.20 INSTALLATION OF METAL DUCTWORK

A. Installation of Metal Ductwork:
   1. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately with internal surface smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
   2. Sealing: All ductwork joints and seams shall be sealed with flexible duct sealer to assure an airtight installation.

3. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.
   a. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate.
4. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
5. Installation: Install metal ductwork in accordance with "SMACNA HVAC Duct Construction Standards".

B. Installation of Duct Liners:
1. General Install duct liners in accordance with SMACNA "HVAC Duct Construction Standards".

C. Installation of Flexible Ducts:
1. Maximum Length: For any duct run using flexible ductwork, do not exceed 4'-0" extended length.
2. Installation: Install in accordance with Section II of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

D. Field Quality Control:
1. Leakage Tests: After each duct system, which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA "HVAC Air Duct Leakage Test Manual". Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.

E. Equipment Connections:
1. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery.

F. Adjusting and Cleaning:
1. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
2. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until final connections are to be completed.
3. Balancing: Refer to Division 23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.

3.21 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install turning vanes in square or rectangular 90 degree elbows in supply, return, and exhaust air systems, and elsewhere as indicated.

C. Install volume and/or splitter damper with adjusting rod in each supply branch. Install according to detail on drawings.

D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

E. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

F. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

G. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

H. Furnish extra fusible links to owner, one link for every 10 installed of each temperature range; obtain receipt.

3.22 INSTALLATION OF ACOUSTIC DUCT LINING

A. Installation: All portions of duct designed to receive duct liner shall be completely covered. The smooth, black coated surfaces shall face the airstream. All liners shall be cut to assure tight, overlapped corner joints. The top pieces shall be supported by the side pieces. The liner shall be adhered to the sheet metal with full coverage of an approved adhesive that conforms to ASTM C 916, and all exposed leading edges and transverse joints shall be coated with Permacote factory-applied or field-applied edge coating and shall be neatly butted without gaps. Shop or field cuts shall be liberally coated with "Schuller SuperSeal Edge Treatment" or approved adhesive. The liner shall be additionally secured with mechanical fasteners. The pin length should be such as to hold the material firmly in place with minimum compression of the material.

3.23 INSTALLATION OF SOUND ATTENUATORS

A. Vibration Control and Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General: Install sound attenuators as indicated, and in accordance with manufacturer's installation instructions.

C. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

D. Upon completion of installation test and demonstrate that sound attenuators, and duct connections to sound attenuators, are leak tight.

3.24 INSTALLATION OF AIR OUTLETS AND INLETS

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.

B. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.25 INSTALLATION OF DUCTLESS COOLING UNIT SYSTEMS

A. Vibration Control And Seismic Restraint: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.

B. General:
1. Verify all dimensions by field measurements. Verify roof structure, mounting supports, wall structure, and membrane installations are completed to the proper point to allow installation of wall mounted and roof mounted units. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation. Do not proceed until unsatisfactory conditions have been corrected.
2. Install equipment in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

C. Field Quality Control:
1. Provide the services, to include a written report, of a factory authorized service representative to examine the field assembly of the components, installation, and piping and electrical connections.
2. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.

D. Demonstration:
1. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
2. Start-up service: Place units into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.

E. Training:
1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
2. Schedule training with Owner through the Architect/Engineer with at least 7 days prior notice.

3.26 INSTALLATION OF CONDENSATE DISCHARGE PUMPS

A. Examine areas and conditions under which pumps are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

B. Installation Of Equipment
   1. General: Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in drain pans and locations indicated, and maintain manufacturer's recommended clearances.
   2. Accessories: Install equipment accessories not installed at factory.
   3. Connections: Connect discharge piping as indicated and terminate where indicated on the contract documents.
   4. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to electrical installer.
      a. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

C. Field Quality Control
   1. General: Start-up equipment, in accordance with manufacturer's start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

D. Closeout Procedures
   1. Training: Instruct Owner's personnel in operation and maintenance of condensate discharge pumps.

3.27 INSTALLATION OF FIRESTOP SYSTEMS

A. General: Install firestop systems at all fire-rated construction where penetrated by the Work of this Section.

B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.28 INSTALLATION OF WALL AND CEILING ACCESS DOORS

A. General: Install access doors in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.

B. All access doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the item or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12" X 16"). Furnish access doors to permit thorough inspection. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

3.29 AUTOMATIC TEMPERATURE CONTROLS (DDC)

A. Installation Of Automatic Temperature Controls (DDC):
   1. Installation of Control Systems:
      a. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.

b. Control Wiring: Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
   1) Install circuits over 25-volt with color-coded No. 12 wire in electric metallic tubing.
   2) Install circuits under 25-volt with color-code No. 18 wire with 0.031" high temperature 105° F. (41° C) plastic insulation on each conductor and plastic sheath over all.
   3) Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
   4) Install low voltage circuits, located in concrete slabs, masonry walls, or in mechanical areas, in electrical conduit. Where exposed in occupied areas install all wiring in wiremold.
   5) Power sources from lighting circuits and wall outlets shall not be used to power DDC controllers.

c. Controllers and safety devices:
   1) All safety devices such as freezestats, duct mounted heat detectors, smoke detectors, etc., shall be hard wired to shut down the fans independently. Provide audible alarm with silence switch as well as DDC indication.
   2) Humidifier controls shall be hard wired through fan proof flow differential switch and starter auxiliary contacts to disable humidifier system on fan shutdown. Provide DDC indication.
   3) All supply, return and exhaust fans shall be provided with pressure differential switches. Current sensing devices, starter auxiliary contacts, and relay contacts are unacceptable proof of fan operation.
   4) Primary and standby pumps shall be selectable through the DDC control system. Provide local pilot light to indicate selected pump as well as alarm and silence switch for failed pump. Provide differential pressure switch to prove flow.

2. Adjusting and Cleaning:
   a. Start-Up: Start-up, test, and adjust DDC control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
   b. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
   c. Final Adjustment: After completion of installation, adjust thermostats, control valves, motor and similar equipment provided as work of this section.
      1) Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.
3. CLOSEOUT PROCEDURES:
   a. Owner's Instructions: Provide services of manufacturer's technical representative for 40 hours of onsite instruction on running and basic troubleshooting of DDC control system.
   b. Validation: The automatic temperature control contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequence of operation submitted.
      1) Witnessed validation demonstration shall consist of:
         a) Execute digital and analog commands in English and graphic mode.
         b) Demonstrate all specified diagnostics.
         c) Demonstrate scan, update, and alarm responsiveness.
      2) Comply with Section 018100 Commissioning Requirements.

c. Training:
   1) All training shall be by the automatic temperature control contractor and shall utilize specified manuals and as-built documentation.
   2) Operator training shall include:
      a) Sequence of Operation review.
      b) Sign on-Sign off.
      c) Modifying warning limits, alarm limits and start-stop times.
      d) System initialization.
      e) Use of Portable Operators Terminal.
      f) Troubleshooting of sensors (determining bad sensors).
      g) Point disable/enable.
      h) Software review of Sequence of Operation programs.
      i) Modification of control programs.
      j) Add/Delete/Modify data points.
      k) Use of diagnostics.
      l) Review of initialization.
   3) Training shall be for Owner-designated personnel at the subject site, and shall be scheduled by the Owner with two week notice.

3.30 TESTING, ADJUSTING, AND BALANCING

A. REQUIREMENTS:
1. Requirements include verification of HVAC system operation, measurement of all system capacity, and establishment of the quantities of the mechanical systems as required to meet specifications, and recording and reporting the results.
2. The entire project is considered phased construction, and as such, as each phase of construction is completed the appropriate balancing for that phase of work shall be completed. At the completion of all phases of construction each previous phase of completed balancing must be re-checked and re-adjusted accordingly to match final design conditions. A preliminary report of each phase of construction will be submitted for approval during each phase of construction, and a final balancing report including all phases of construction will be submitted at the completion of the project.
3. Commission, test, adjust and balance the following mechanical systems:
   a. Supply air systems.
   b. Return air systems.
   c. Exhaust air systems.
   d. Outside air systems.
   e. Hydronic heating and cooling systems.
   f. Verify temperature control system operation.
4. Do not include:
   a. Testing boilers and pressure vessels for compliance with safety code.
   b. Installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing. Contact Mechanical Contractor and the Engineer for direction.
5. Comply with Commissioning Test Requirements in Section 018100.

B. REPORT:
1. Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
   a. General Information and Summary.

b. Air Systems.
c. Hydronic heating and cooling systems.
d. Temperature Control Systems.

2. Contents: Provide the following minimum information, forms and data:
   a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the proof of calibration.
   b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC for each respective item and system.
   c. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

C. QUALITY ASSURANCE:
1. An independent testing, adjusting, and balancing agency certified by the AABC or NEBB as a Test and Balance Engineer in those testing and balancing disciplines required for this project.
2. Codes and Standards:
   a. AABC: "National Standards For Total System Balance".
   b. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.
3. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect/Engineer and Mechanical Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.
4. System Operation: Systems shall be fully operational prior to beginning procedures. All new automatic temperature controls shall be fully operational. Test, adjust and balance the air systems before refrigerant systems. Test, adjust and balance air conditioning systems during summer season, and heating systems during winter season, including at least a period of operation at outside conditions within 5E F. wet bulb temperature of maximum summer design condition, and within 10E F. dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.

D. PRELIMINARY PROCEDURES:
1. Air Systems:
   a. Obtain drawings and become thoroughly acquainted with the systems.
   b. Compare drawings to installed equipment and field installations.
   c. Walk the system from the system air handling equipment to terminal units to determine variations in installation.
   d. Check filters for cleanliness.
   e. Check all dampers (volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
   f. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross check with required fan volumes.
   g. Determine best locations in main and branch ductwork for most accurate duct traverses. Traverses shall be performed in each supply and return duct main and sub-mains for each AHU and return air fan.
   h. Place outlet dampers in the full open position.

i. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
j. Verify lubrication of all motors and bearings.
k. Check fan belt tension.
l. Check fan rotation.

2. Hydronic Systems:
   a. Open valves to full open position. Close coil bypass valves.
   b. Remove and clean all strainers.
   c. Examine hydronic systems and determine if water has been treated and cleaned.
   d. Check pump rotation.
   e. Check expansion tanks to verify noted air pressure and that the system is completely full of water.
   f. Check air vents at high points of system and determine if all are installed and operating freely.
   g. Set temperature controls so all coils are calling for full flow.
   h. Check operation of automatic bypass valves.
   i. Check and set operating temperatures of chillers, boilers, and heat exchangers to design requirements.
   j. Verify lubrication of all motors and bearings.
3. Measurements:
   a. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerance specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
   b. Provide instruments meeting the specifications of the referenced standards.
   c. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
   d. Apply instrument as recommended by the manufacturer.
   e. Use instruments with minimum scale and maximum subdivisions and with scaled ranges proper for the value being measured.
   f. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
   g. Take all reading with the eye at the level of the indicated value to prevent parallax.
   h. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
   i. Take measurements in the system where best suited to the task.

E. Performing Testing, Adjusting, and Balancing:
1. Test, adjust and balance all noted systems according to SMACNA standards and as follows:
   a. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
   b. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
   c. Patch insulation, ductwork, and housings, using materials identical to those removed.
   d. Seal ducts and test for and repair leaks.
   e. Seal insulation to re-establish integrity of the vapor barrier.
   f. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
   g. Retest, adjust and balance system subsequent to significant system modifications, and resubmit test results.

2. System Deficiencies:
   a. The Balancing Contractor shall advise the Mechanical Contractor and the Engineer of all system deficiencies in writing. Report all motors not running, missing dampers, inoperative valves and controls, lack of access, etc.
   b. Upon completion of system deficiencies, Balancing Contractor shall balance and record data.

END OF SECTION

SECTION 230548

VIBRATION CONTROL AND SEISMIC RESTRAINT

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END OF SECTION

SECTION 230548

VIBRATION CONTROL AND SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 DESCRIPTION

A. General: The work noted within section 230548 is referenced by division 210000, 220000, 230000, 260000. Provide all necessary labor & material in each division as required herein.

B. Intent:
1. All mechanical equipment, piping, and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
3. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's, and building construction standards. Whenever a conflict occurs between the manufacturer's or construction standards, the most stringent shall apply.
5. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
6. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

C. The work in this section includes, but is not limited to the following:
1. Vibration isolation for piping, ductwork and equipment.
2. Equipment isolation bases.
3. Flexible piping connections.
4. Seismic restraints for isolated equipment.
5. Seismic restraints for non-isolated equipment.
6. Certification of seismic restraint designs and installation supervision.
7. Certification of seismic attachment of housekeeping pads.
8. All mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical. (Equipment not listed is still included in this specification).

AC Units
Air Cooled Condensing Units
Air Handling Units
Air Separators
Battery Racks
Boilers
Bus Ducts
Cable Trays
Chillers
Comp. Room Units
Conduit
Cooling Towers
Generators
Heat Exchangers
Light Fixtures
Motor Control Ctrs
Piping
Pumps (all types)
Rooftop Units
Switching Gear
Tanks (all types)
Transformers
Unit Heaters
Unit Substations

Ductwork	Var. Freq. Drives
Dust Collectors	VAV Boxes
Electrical Panels	Water Heaters
Fans (all types	

D. Definitions:
   1. Life Safety Systems
      a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems.
      b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers, and all flowpaths to fire protection and/or emergency lighting systems.
      c. All medical and life support systems.
      d. Fresh air & relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.
   2. Positive Attachment
      a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, etc. are not acceptable as seismic anchor points.
   3. Transverse Bracing
      a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.
   4. Longitudinal Bracing
      a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.2 SUBMITTAL DATA REQUIREMENTS

A. In addition to requirements of Section 01300, the manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:
   1. Descriptive Data
      a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
      b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
   2. Shop Drawings
      a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
      b. Provide all details of suspension and support for ceiling hung equipment.
      c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
      d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
   3. Seismic Certification and Analysis
      a. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.

b. All restraining devices shall have a pre-approval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Pre-approvals based on independent testing are preferred to pre-approvals based on calculations. Where pre-approved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 450 to the weakest mode.

c. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embodiment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces required acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.3 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable Codes, Standards, and Categories:
1. International Building Code 2009 with an effective peak acceleration coefficient of 0.15.
2. Massachusetts State Building Code, Eighth Edition.
3. Seismic hazard exposure group of I, II, III and seismic performance category of C, D.

1.4 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:
1. Determine vibration isolation and seismic restraint sizes and locations.
2. Provide vibration isolation and seismic restraints.
3. Provide calculations and materials if required for restraint of unisolated equipment.
4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.5 RELATED WORK

A. Housekeeping Pads:
1. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embodiment.

B. Supplementary Support Steel:
1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment.

C. Attachments:
1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.6 DESIGN REQUIREMENTS

A. Design isolators for equipment installed outdoors to provide adequate restraint to withstand the force of a 100 mph wind applied to any exposed surface of the isolated equipment. Isolators for outdoor equipment shall have bolt holes for attachment to equipment and to supports. The vibration isolation Vendor shall submit verifying shear and over turning calculations, for their product and equipment installation arrangement, stamped by a licensed Professional Engineer. The design and supply of miscellaneous support steel above and below isolators will not be the responsibility of the vibration isolation manufacturer.

1.7 QUALITY ASSURANCE

A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.

B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.

C. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.

D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

E. Should any rotating equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 INTENT

A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industry's products are the basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with the specification.

B. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater that 1/4 inch.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraints.

GENERAL:

1. All metal parts installed out-of-doors shall be corrosion resistant after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.

2. Isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
4. Static deflection of isolators shall be as provided in the EXECUTION section and as shown on the drawings. All static deflections stated are the minimum acceptable deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

SPECIFICATION:

1. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 1 6 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. A one (1) piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Pre-approval "R" Number from OSHPD in the state of

California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc.

7. Spring mountings as in specification 5 built into ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4 inch travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8". Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30° as manufactured by Mason Industries, Inc.
11. Hangers shall be as described in specifications 10, but they shall be pre-compressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.

13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.

    Note: Specifications 12 - 14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose performed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. Rated loading shall not exceed 1,000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1 225 as manufactured by Mason Industries, Inc.
17. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Rated loadings shall not exceed 1,000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more that 1/4". Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" deflection in the x, **y** and z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-101 1 as manufactured by Mason Industries, Inc.
18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.0 Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.

19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.0 Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14' provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 ". Bases shall be type WF as manufactured by Mason Industries, Inc.
21. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/1 2 of the longest dimension of the base but not less than 6". The base depth need not exceed 1 2" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1 " clearance below the base. Wooden formed bases leaving a concrete rather then a steel finish are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
22. Roof Curb (by HVAC Contractor)
    a. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.
    b. Unit shall be provided with wood nailer and flashing.
    c. Curbs shall meet all NRCA Standards.
    d. Curbs shall be similar to Novia Associates VibCurb III or equal having a minimum 3" rated static deflection or approved equal.
    e. Vibration control: The spring roof curb shall have the top isolated or floating rail attached in a manner to the fixed lower portion of the curb without short circuiting or bridging between the two. Restraining bolt(s) or threaded rod shall be of sufficient size to withstand the applied wind & or seismic forces at each spring pack location.
    f. An alignment bolt shall be installed before connecting the floating to non-floating parts to guarantee perfect centering of the restraining bolts.
    g. Weather proofing & air seal: The spring curb must keep the weather (air and water) out and any airflow from the RTU in. The weather seal must not have the ability to fail and allow water or air into the building.
    h. The use of exposed exterior neoprene or some other elastomer material to seal the top floating rail from the base of the curb in not acceptable.
    i. Vibration Mountings: Provide a rubber gasket covered by formed galvanized sheet metal top flashing that overhangs the top wood nailer and galvanized bottom flashing. The overlapping shall effectively cover the rubber gasket so it is protected from the elements.

j. The top flashing / support rail shall be 14 ga. G60–Zc steel formed with 90 bends that extend down to the wood nailer. Provide a counter flashing member with a sponge gasket attached that presses up against the horizontal bend. The seal shall be replaceable, protected from the elements and easy to install.

k. Curb side material: Provide 12 Ga. G60 galvanized steel for curb side construction. All side and end seam between sheets shall be continuously welded, corner joints to be caulked and bolted.

l. Structural Capability:
   1) Curbs shall be installed on metal decking/concrete slab. Air handling unit load shall be properly distributed. Coordinate curb construction with pitch of roof. Curbs shall be built to match the roof pitch in accordance with all requirements of this project. Positive attachment of the curb to the structure is imperative. Pitch correction shall be fabricated from 12 gauge galvanized material and be continuous on all sides and ends. Field fabricated and installed tube steel stub-ups are not acceptable. HVAC contractor shall provide detailed information to the curb manufacturer regarding pitch correction.
   2) Plenum Sections: The side material must be capable of handling the static pressure developed by the fans and not ‘oil can’. Provide spanning bar joists as required to support plenum installation (even when the spring pockets are center span).
   3) Provide a continuous bottom tube steel member or side material of sufficient strength. Mechanical contractor shall coordinate and verify all dimensions, weights, roof penetrations, etc. with the Structural Engineer prior to installation.
   4) Curb Insulation: Provide spring curbs with a space between the floating and non-floating parts for the installation of insulation. Curb manufacturer shall provide factory installed insulation adhered to roof curb. Curbs shall be externally factory insulated with a 1.7” thick R-12 foam insulation, FM Class 1 and UL Class A Ratings, with bonded fiber reinforced facer.

m. Protection: Curbs shall be completely shrink-wrapped during shipping.

n. Mechanical contractor shall provide all necessary materials to completely weather proof and sound proof the curb installation.

o. Additional features:
   1) Sound barrier: Provide a sound barrier package, consisting of G60 galvanized back-to-back angles. Sound barrier package shall be capable of supporting two layers of 1/2" Durock concrete board with a maximum deflection over the width of the curb of L/360. Durock furnished and installed by the HVAC Contractor. Overlap all joints, caulk all seams and edges. Transmission Loss & STC shall be as shown as follows. Sound Transmission Loss at Frequency (Cycles per second) of (125)=20, (250)=27, (500)=30, (1000)=32, (2000)=30, (4000)=38, (STC)=31.
   2) Provide with framed Supply & Return air duct openings. Openings shall match duct sizes and have 1" galvanized steel flanges.
   3) Plenum sections: Where indicated on the drawings, provide in the interior of the curb, double wall acoustical floor, walls and plenum divider. All insulation shall be 2" thick fiber glass acoustical duct liner with reinforced coating system. Insulation acoustical performance shall be as follows. Liner shall not support microbial growth and shall be EPA registered and pass ASTM C 1071 & ASTM G21 bacterial tests conducted in accordance with ASTM G22. Floors up to 90" curb I.D. width shall be constructed of 22 Ga., 20 Ga. thereafter, solid G60 galvanized bottom panels and 22 Ga. galvanized perforated 22.7% open area top panel. Floor shall be attached to walls and plenum divider to provide an airtight plenum. Walls shall have 22 Ga.

galvanized perforated 22.7% open area inside panels. Plenum divider shall be double wall 22 Ga. perforated galvanized 22.7% open area panel on the supply side with a 14 gauge solid panel opposite. Sound Absorption Coefficient at Frequency (Cycles per second) of (125)=.23, (250)=.64, (500)=.99, (1000)=1.05, (2000)=1.00, (4000)=.98, (NRC)=.90,

23. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Dacron tire cord friction ring. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16' to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190°F. with a uniform drop in allowable pressure to 190 psi at 250°F. 16" and larger connectors are rated 180 psi at 190°F. and 135 psi at 250°F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints.

    Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves.

    Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged		Male Nipples	
3 x 14	10 x 26	½ x 9	1-½ x 13
4 x 15	12 x 28	¾ x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	
8 x 22			

    Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
26. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of ± 1 5/8" motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
27. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of I" past either face of the wall. Where temperatures exceed 240°F., 10# density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 GENERAL

A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data. At the completion of all construction work the vibration and seismic device supplier shall inspect all installations and provided a written report of installation compliance to the engineer of record. A copy of this written certification shall also be provided in the operations manual provided to the owner.

B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractors expense.

G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractors expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractors expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
   1. Flanges of structural beams.
   2. Upper truss cords in bar joist construction.
   3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

K. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.

L. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.

M. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.

N. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.

O. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.

P. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.

Q. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.

R. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be specification type 28.

S. Locate isolation hangers as near to the overhead support structure as possible.

3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF PIPING, DUCTWORK, AND CONDUIT

A. Where piping connects to rotating or vibrating mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Seismic Restraint of Piping:
1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables.
   a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping.
   b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" I.D. and larger.
   c. All other piping 2 1/2" diameter and larger.
2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.

C. Pipe Isolation
1. All chilled water, condenser water, hot water, steam, refrigerant, drain and engine exhaust piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:

   Within mechanical rooms;

   Within 50' total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.);
   At every support point for piping that is greater than 4 inches in diameter.
2. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.
3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2", Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2", Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least 1/4" static deflection.
4. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
6. Provide flexible pipe connections as called for under Major Equipment above and wherever shown on the drawings.

D. Seismic restraint of ductwork:
   1. Seismically restrain all duct work with specification 12 or 13 restraints as listed below:
      a. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
      b. Restrain round ducts with diameters of 28" or larger.
      c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
   2. Transverse restraints shall occur at 30' intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
   3. Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
   4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
   5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
   6. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

E. Duct Isolation:
   1. All sheet metal ducts and air plenums that are within mechanical rooms or within a distance of 50' total duct length of connected vibration-isolated equipment (whichever is longer) shall be isolated from the building structure by Type FN, PCF or HN isolators. All isolators shall achieve 0.1" minimum static deflection.
   2. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
   3. Flexible duct connections shall be provided as called for above under Major Equipment and wherever shown on the drawings.

F. Seismic Restraint of Electrical Services:
   1. All electrical conduit 2-1/2" in diameter and larger shall be restrained with specification type 12 seismic cable restraints or specification type 13 for seismic solid brace restraints.
   2. All electrical bus ducts, cable trays and ladder trays shall be restrained with specification type 12, seismic cable restraints or specification 13 seismic solid brace restraints.
   3. Transverse restraints shall occur at 30' intervals or both ends if the electrical run is less than the specified interval. Transverse restraints shall be installed at each electrical services turn and at each end of the electric run.
   4. Longitudinal restraints shall occur at 60' intervals with at least one restraint per electric run. Transverse restraints for one electric section may also act as a longitudinal restraint for a duct for an electric section connected perpendicular to it if the restraints are installed within 4' of the intersection of the electric run and if the restraints are sized for the larger electric run.
   5. All rigid floor mounted equipment must have a resilient media between the equipment mounting hole and the anchor bolt. Neoprene bushings shall be specification type 4 and anchor bolts shall be specification type 18 or 19.
   6. Wall mounted panels shall be mounted with specification type 3 bushings. Floor mounted panels shall be mounted on specification type 4 bushings. Anchor bolts shall be specification type 18 or 19.

G. All fire protection piping shall be braced in accordance with NFPA 13 and 14.

H. All mechanical equipment shall be vibration isolated and seismically restrained.
   1. All fire protection equipment is considered life safety equipment and shall be seismically restrained.

3.3 SEISMIC RESTRAINT EXCLUSIONS

A. Piping:

   1. All piping less than 2 1/2” except for gas and fire protection piping.
   2. All piping in boiler and mechanical equipment rooms less than 1 1/4" I.D.
   3. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12" in length from the structure to the structural connection of the clevis or trapeze.
   4. All PVC and fiberglass suspended waste or vent pipe 6" in diameter and smaller.

B. Ductwork:
   1. Rectangular, square or oval ducts less than 6 sq.ft. in cross sectional area.
   2. Round duct less than 28" in diameter.
   3. Duct supported by hanger rods where the point of attachment is less than 12" in length from the structure to the structural connection of the duct work.

C. Electrical:
   1. All conduit less than 2 1/2" diameter suspended by individual hanger rods.
   2. All clevis or trapeze supported conduits suspended by hanger rods where the point of attachment is less than 1 2" in length from the structure to the structural connection of the clevis or trapeze.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General
   1. **Locations** of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.
   2. **Installation** of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolators
   1. All vibration isolators shall be aligned squarely above or below mounting points of the supported equipment.
   2. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
   3. Locate isolators to provide stable support for equipment, without excess rocking. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
   4. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
   5. Hanger rods for vibration-isolated support shall be connected to major structural members, not the floor slab between major structural members. Provide suitable intermediate support members as necessary.
   6. Vibration isolation hanger elements shall be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.

7. Parallel running pipes may be hung together on a trapeze that is isolated from the building. Isolator deflections must be the greatest required by the provisions for pipe isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
8. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
9. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
10. The installed and operating heights of equipment supported by Type FSNTL isolators or with Type RC-2 isolation bases shall be identical. Limit stops shall be out of contact during normal operation. Adjust isolators to provide 1/4" clearance between the limit stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
11. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases
1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.
2. Unless otherwise indicated, there is to be a minimum operating clearance of 1" between steel rails, steel frame bases or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
3. Isolation bases shall be installed in strict accordance with the manufacturer’s instructions.

D. Flexible Duct Connections:
1. Prior to installation of the flexible connection, sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section, and the gap between connected parts shall be uniform. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.

E. Flexible Pipe Connections:
1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.

F. Thrust Restraints:
1. Thrust restraints shall be attached on each side of the fan parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.

G. Grommets:
1. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.

H. Resilient Penetration Sleeve/Seals:
   1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

END OF SECTION

SECTION 23 08 00
COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. ASHRAE Guideline 1-2007, *HVAC&R Technical Requirements for the Commissioning Process*

C. OPR and BoD documentation are included by reference for information only.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
2. Division 23 Mechanical
3. Division 28 Electronic Safety and Security for interaction with fire alarm systems

1.03 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the HVAC&R systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
1. Boilers and related equipment
2. Chillers and related equipment
3. Pumps and Drives
4. Hot water system
5. Chilled water system
6. Air Handling Units with Energy Recovery
7. Rooftop Air Handling Units
8. Split System Air Conditioning Units
9. Exhaust fans and systems
10. Supply or make-up air systems
11. Unit Ventilators
12. Fan Powered VAV
13. Specialty air removal/ventilation systems (including fans, ductwork and interconnection with air handling/supply systems)
14. Ductwork systems
15. Piping Systems
16. Terminal heating units (unit heaters, reheat coils, fintube, radiant ceiling panels)
17. Additional Items to be added as required

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.02 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
1. The system or assembly is completely installed, functional, and documented through checklists.
2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
3. All contractor-performed start-up procedures and tests are complete and documented.
4. Preliminary trending data provided to verify actual system operation.
5. The system or assembly is ready for the Owner to take beneficial use.

3.03 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. Boilers and related equipment
2. Chillers and related equipment
3. Pumps and Drives
4. Hot water system
5. Chilled water system
6. Air Handling Units with Energy Recovery
7. Rooftop Air Handling Units
8. Split System Air Conditioning Units
9. Exhaust fans and systems
10. Supply or make-up air systems
11. Unit Ventilators
12. Fan Powered VAV
13. Specialty air removal/ventilation systems (including fans, ductwork and interconnection with air handling/supply systems)
14. Terminal heating units (unit heaters, reheat coils, fintube, radiant ceiling panels)
15. Building automation system
16. HVAC, Test, Adjust, and Balance
17. Additional Items to be added as required

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
2. Division 23 Mechanical
3. Division 28 Electronic Safety and Security.

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.04 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.02 SUMMARY above for the sections) for review.

3.05 SAMPLE FORMS

Installation Checklist
Roof Top Unit # _____Serving Room/Area/Floor _____

Model Verification

	Specified	Submitted	Installed
Manufacturer			
Model Number			
Serial Number			
Inlet Size			
Cool CFM / Heat CFM			

Installation Checks

ID	Description	Pass / Fail	Comments
1	Verify the unit has been installed on a roof curb. Entire length and width under base shall be sealed for additional water management protection. (15500 2.42D)	☐ ☐	
2	The piping cabinet shall have removable panels or optional access door of the same construction as unit door. (15500 2.42H)	☐ ☐	
3	Verify view windows are provided for all fan section access doors and is made of tempered glass. (15500 2.42K)	☐ ☐	
4	Verify that a factory mounted light fixtures are provided in all sections of the unit that have access doors. Provide individual light switches installed adjacent to access doors. (15500 2.42L)	☐ ☐	
5	Coils shall be removable by unbolting the wall panels in the coil section. Connections shall be clearly labeled on the outside of units. (15500 2.42O)	☐ ☐	
6	Verify filter section shall have filter racks, an access door for filter removal and block offs as required to prevent air bypass around filters. Units shall be supplied with 4" flat and 12" cartridge bag filters. (155500 2.42P)	☐ ☐	
7	Verify factory wired disconnect switches for each fan (VSDs are to be mounted in the building not within the rooftop unit). Also provide factory wired lights and GFI receptacles (two per unit). (15500 2.42V)	☐ ☐	
8	Provide smoke rated damper assembly for both supply and return air openings for RTU-1, 7 and 9. (15500 2.42W)	☐ ☐	
9	Provide isolation damper assemblies for both supply and return air openings for all rooftop units except RTU-1, 7 and 9. (15500 2.42X)	☐ ☐	
10	Verify the following piping components have been installed in the direction of flow for the CW/HW supply: (M4-2-0) a. Thermometer b. Butterfly Valve c. Strainer with hose end drain valve with cap and chain. d. Union e. ¾" Hose end drain valve with cap and drain.	☐ ☐	
11	Verify the following piping components have been installed in the direction of flow for the CW/HW return: (M4-2-0) a. Automatic Air Vent b. Union c. 2-Way Control Valve d. Union e. Butterfly Valve with Memory Stop	☐ ☐	

	f. Thermometer		

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Contractor/Manuf. Rep.			
Engineer			
Construction Administrator			
Commissioning Agent			

Sample Functional Performance Test

Heat Recovery Rooftop Unit – ERV-2

1. Participants

Name/Representing		Participation (Testing, Witness, etc)
/		
/		
/		

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

a. ☐ A completed and approved balancing report has been provided.

b. ☐ An as-built version of the controls submittal has been provided.

c. ☐ The controls contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. CC initials: _____. Date: _____.

d. ☐ The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _____. Date: _____.

e. ☐ Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc., that have been changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Occupied space temperature heating setpoint		☐
Occupied space temperature cooling setpoint		☐
Frost Control temperature alarm setpoint		☐
Occupied/Unoccupied mode		☐
Occupied Space Humidity Setpoint		☐
		☐

Parameter	Pre-Test Values	Returned to Pre-Test Values √
Unoccupied space temperature heating setpoint		☐
Unoccupied space temperature cooling setpoint		☐
Occupied low space temperature alarm setpoint		☐
Occupancy Schedule		☐
Low Limit Switch SP		☐
		☐

3. Sensor Calibration Checks. The sensors listed below are to be checked for calibration and adequate location.

Sensor	Location OK[1]	BAS Value	Measured Value	Pass Y/N
Outside air temperature	Y / N			Y / N
Space temperature	Y / N			Y / N
RAT - avg.	Y / N			Y / N

Sensor	Location OK[1]	BAS Value	Measured Value	Pass Y/N
WDAT (CLT) - avg	Y / N			Y / N
DAT - avg.	Y / N			Y / N
Discharge Air Humidity	Y / N			Y / N

[1] *Sensor location is appropriate and away from causes of erratic operation.*
Comments:

4. Device Calibration Checks. The actuators or devices listed below are to be checked for proper operation and/or calibration.

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
Outside air damper / actuator	1. Observe OA damper modulating in unison with RA and EA damper.			Y / N
Exhaust air damper / actuator	1. Observe EA damper modulating in unison with RA and OA damper.			Y / N
Exhaust air fan status	Stop			Y / N
	Start			Y / N
Return air damper / actuator	1. Observe during outside air damper testing. Return air damper should operate inversely with the outside air damper.			Y / N
Supply air fan and status	1. Stop	/Status		Y / N
	2. Start	/Status		Y / N
Electric Duct Heat	1. Off			Y / N
	2. On			Y / N
Heat Recovery Wheel	Stop			Y / N
	Start			Y / N
H/C Valve	Fail Position			Y / N

Device or Actuator	Procedure / State	BAS Value	Site Observation	Pass Y/N
Outside air damper / actuator	1. Observe OA damper modulating in unison with RA and EA damper.			Y / N
Exhaust air damper / actuator	1. Observe EA damper modulating in unison with RA and OA damper.			Y / N
Exhaust air fan status	Stop			Y / N
	Start			Y / N
	50 % Open			
	100 % Open			
Low Limit Switch	Trip			Y / N

5. Notes

6. Functional Testing Record

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1	UNOCCUPIED MODE (**Vacation Periods Only**)	1. Command the unit to the unoccupied mode through the BAS. 2. When the unit is in the unoccupied mode command the unoccupied space temperature heating setpoint to 5°F above the current average space temperature. 3. When the unit is in the unoccupied mode command the unoccupied space temperature heating setpoint to 5°F below the current average space temperature. Note: This may not be set up, as no sequence was provided.	1. The outside air dampers will be closed. The return air damper will be open 100%. Observe fail position of DTW (HCV) valve. The heating unit will cycle to the unoccupied set point of 60deg (adj). The supply air fan will be off. This is the "shutdown" mode for the unit. 2. The outside air dampers will remain closed. The return air damper will remain open. The supply air fan will be on. The heating module will start. 3. The heating module will be de-energized. The supply air fan will stop. The unit will return to shutdown mode.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
3	OCCUPIED MODE HEATING (SYSTEM INDEXED TO HEAT)	1. Command the unit to occupied mode. 2. When the unit is in the occupied mode adjust the space temperature heating setpoint to 5°F above the current space temperature. Note: If system is not indexed to heating mode DTW (HCV) valve will remain closed.	1. The supply air fan will start. The outside, return and exhaust air dampers will modulate to maintain a minimum discharge air temperature setpoint of 53° F at sensor CLT. Heat wheel speed will control at this setpoint. 2. The supply air fan will remain on line. The outside, return and exhaust air dampers will continue modulating. The DTW (HCV) will modulate to heat the space until the setpoint is satisfied. Discharge air temperature is limited to 55 to 80 Deg F.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
4	OCCUPIED MODE ECONOMIZER (COOLING MODE INDEXED)	**1. Note: May not apply not specified in sequence of operation.** 2. When the unit is in the occupied mode override the outside air temperature to 48°F. Command the space temperature occupied cooling setpoint to 5°F above the current space temperature and the occupied heating setpoint to 5°F below the current space temperature. Command the mixed air temperature setpoint to 5°F below the current mixed air temperature. Command the mixed air temperature setpoint to 5°F above the current mixed air temperature. 3. Command the mixed air temperature setpoint to 5°F above the current mixed air temperature.	1. The supply air fan will remain on. The outside, return and exhaust air dampers will modulate to provide more outside air, in a direct action control algorithm, to maintain the mixed air temperature setpoint of 55 degrees. If the cooling setpoint is not met then the DWT (HCV) valve will modulate open to met space setpoint. 2. The supply air fan will remain on. The outside, return and relief air dampers will modulate to provide less outside air, in a direct action control algorithm, to maintain the mixed air temperature setpoint.	Y / N	
5	HEAT RECOVERY MODE	1. Normal operation	1. The heat recovery wheel is rotating with the exhaust air passing thru the wheel and the OA passing thru the wheel to warm air or cool air. No air is bypassing wheel	Y / N	
6.	OCCUPIED DEHUMIDIFICATION (COOLING MODE INDEXED ONLY)	1. With system indexed to cooling and the system is in occupied mode lower space humidity setpoint (62%) 10% lower. 2. Return to normal.	1. DTW (HCV) will modulate and electric heater will stage on and off to maintain space setpoint. This is the only function of the electric heater. 2. DTW valve will return to normal control and the electric heater will stage off.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
7.	OCCUPIED COOLING (COOLING MODE INDEXED)	1. With the system in occupied mode, lower space temperature setpoint (75) as sensed by TR, 5 Deg F. lower than current space temperature. 2. Return to normal.	1. The heat wheel increase speed to shed return air heat and the DWT (HCV) valve will modulate open to maintain new space setpoint. DAT shall never drop below 55 Deg. F. Allow time for control to stabilize.	Y / N	
8.	FROST CONTROL	1. With the unit running, raise the frost control setpoint as sensed at TF, 5 Deg F higher than current exhaust air temperature. 2. Reset alarm time delay for exhaust air temperature to 2 minutes. 3. Return all to normal.	1. Observe heat wheel slow to raise exhaust air temperature to high setpoint. 2. Observe low exhaust air alarm at BAS.	Y / N	
9.	FREEZE STAT ALARM AND SHUTDOWN	1. With the unit running in the occupied mode, trip the low limit thermostat located upstream of the HC coil. 2. Manually reset the freeze alarm at the BAS.	1. The unit will shut down, and all dampers will go to their fail state, and DTW (HCV) valve will fail open to the coil. The BAS will indicate a freeze alarm. 2. The unit will start in occupied mode.	Y / N	
10	DIRTY AIR FILTER ALARM	1. With the unit operating, decrease the dirty filter alarm delay time to 2 minutes, and then gently pump up the high side of the filter DP. 2. Return to normal.	1. Check that the BAS alarms.	Y / N	
8	SUPPLY AIR FAN ALARM AND SHUTDOWN	1. With the unit running in the occupied mode, stop the supply air fan by turning it off at its starter.	1. The unit will go to its shutdown mode. The BAS will indicate a supply air fan status alarm.	Y / N	
9	EXHAUST FAN SHUTDOWN	1. With the unit running in the occupied mode, stop the exhaust fan by turning it off at its starter.	1. The unit will go to its shutdown mode. The BAS will indicate an exhaust fan status alarm.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
11	TRENDS	Set the following points for 15 minute trend samples and review in 48 hours: 1. Space temperature. 2. Supply air fan status. 3. Exhaust air fan status 4. Mixed air temperature. 5. Outside air temperature. 6. Mixed air damper position 7. Room Humidity 8. Supply Air Temperature	Trend Data	Y / N	

-- END OF TEST --

END OF SECTION 230800

SECTION 260000

ELECTRICAL
(Filed Sub-Bid Required)

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SECTION 260000

ELECTRICAL
(Filed Sub-Bid Required)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Examine all other Sections of the Specifications for requirements that affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 GENERAL REQUIREMENTS

A. The Conditions of the Contract and General Requirements of the Project Manual apply to Section 260000 Sub-Bid Contractor, material suppliers, and all other persons furnishing labor and materials under this Section. General Conditions, Supplementary General Conditions, and applicable parts of Division 1 are included as part of this Section.

B. Examine all Project Specifications and Drawings for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Refer to Section 012300 for ALTERNATES which may affect the work of this Section.

D. Coordinate work with that of all other trades effecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

E. The following definitions apply to the Drawings and Specifications:
1. Furnish: The term “furnish” is used to mean “supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
2. Install: The term “install” is used to describe operations at project site including actual “unloading, unpacking, rigging in place, assembly, erection, piecing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations”.
3. Provide: The term “provide” means to “furnish and install, complete and ready for the intended use”.
4. Installer: An “installer” is the Contractor or an entity engaged by the Contractor, either as an employee, Subcontractor, or Sub-Subcontractor for performance of a particular construction activity, including installation, erection, application, and similar operations. Installers are required to be experienced in the operations they are engaged to perform.
5. Conduit: Raceways of the metallic type which are not flexible. Specific types as specified.
6. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.

7. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.

F. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch where work is being performed and until it is completed.

G. "Furnish and install, removing when no longer needed, all temporary lifts, hoists, staging, scaffolding, rigging, labor and materials, and temporary support to perform all operations in connection with the installation of this work." Coordinate with Division 1.

1.3 SUMMARY OF WORK

A. Work described herein shall be interpreted as work to be done by the Electrical Subcontractor. Work to be performed by other trades will be referenced to a particular contractor or subcontractor.

B. Provide all labor, materials, tools, and equipment, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. Systems may be referenced in singular or plural terms, also refer to drawings to confirm quantities. The work shall consist of, but shall not necessarily be limited to, the following:

1. Primary, secondary, and low tension ductbanks, manholes, handholes, etc.
2. Secondary distribution equipment, including secondary switchboard, metering, motor controls, variable frequency drives, dry-type transformers, distribution panels, including feeders and subfeeders.
3. Fire alarm system, addressable type.
4. Emergency power system, including diesel fired emergency generator, emergency lighting and exit signs.
5. Lighting systems exterior and interior, including lamps, fixtures, controls, etc.
6. All raceway systems, including boxes, couplings, and fittings.
7. All branch circuit wiring systems, including wiring devices, plates, etc.
8. Connections for all building equipment, including mechanical, plumbing, fire protection, elevators, owner furnished equipment, and the like.
9. Core drilling for electrical conduit systems and equipment in accordance with Section 017320 – Cutting and Patching.
10. Cutting through non-masonry construction in accordance with Section 017320 – Cutting and Patching.
11. Systems Identification.
12. Scaffolding, rigging, and staging required for all electrical work in accordance with Section 015000 – Temporary Facilities and Controls.
13. All through-penetration firestopping required by this Section shall be provided by the Electrical Contractor in accordance with Division 07, Section 078400 “Firestopping”. Refer to architectural drawings for surfaces to be fireproofed.
14. Provide Seismic Restraints for all Electrical Systems conforming to the requirements of Section 23 05 48 which Section is herein incorporated by reference. Provide all work as required.
15. Coordination Drawings.

16. Communications system provisions including cable tray, 120 volt sources, outlet boxes and raceway system, grounding, firestopping, etc. for voice, data, cable TV, paging, intercom, local sound systems, clock, etc. as required and as specified in Section 270010.
17. Alternates affecting this section.
18. Automated Lighting Control System (digital addressable).
19. Company switches
20. Commissioning requirements per Section 018100.
21. Scoreboards and Shot Clocks.
22. Lightning Prevetnor System.
23. Furnish access doors and frames in accordance with Section 083100 – Access Doors and Frames.
24. Sealing of all penetrations through walls, slabs, partitions, which are not fire rated.
25. Install Stage Dimming and Theatrical lighting system, furnished by Stage Lighting/Rigging Contractor under Section 110640. Provide all conduit, both low and high voltage, high voltage wire and terminations. Refer to equipment shown on TL series drawings.
    a. Provide all conduit, both control and high voltage, high voltage wire and terminations for motorized batten hoists over the audience seating area. Batten hoists furnished and installed by Section 110640 contractor. Refer to equipment shown on TR drawings.
    b. Provide all conduit, both control and high voltage, high voltage wire and terminations for ten(10) motorized batten hoists over the stage area. Batten hoists furnished and installed by Section 110640 contractor. Refer to equipment shown on TR drawings.
    c. The matrix of responsibilities indicated in Paragraph 2.27 is intended as a guide for delineating the work between the Electrical Contractor and the Stage Lighting/Rigging Contractor, Section 110640.
    d. Receive and store dimming system equipment supplied by the Section 110640 Contractor.
26. Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts. Project scores will be verified by a third party certifier.
    a. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.
27. All testing of equipment installed.
28. Any other item of work hereinafter specified or indicated on electrical drawings.
29. Provisions only for a 60kw photovoltaic system as indicated on drawings.
30. TV Studio dimming control and lighting system.
31. Disconnect services and make existing building safe for demolition by general contractor.

1.4 ITEMS TO BE FURNISHED ONLY

A. Furnish the following items for installation under designated sections.
   1. Duct smoke detectors with sampling tube: Section 230000 - HVAC.
   2. Access Panels: Section 083100 – Access Doors and Frames.

1.5 ITEMS TO BE INSTALLED ONLY

A. Install the following items furnished under designated sections.
   1. Theatre Dimming Equipment: Section 110640 – Theater Equipment and as shown on TL drawings.
   2. Specialty Backboxes for Communications System, i.e; Speakers, etc.: Section 270000 – Communications.

1.6 RELATED WORK

A. The following related work is to be performed under designated sections.
1. Temporary Controls – SECTION 015000 – TEMPORARY FACILITIES AND CONTROLS.
2. Excavation and Backfill: DIVISION 31 – EARTHWORK (except within building foundation).
3. Precast Bases, Concrete Pads and Duct Envelopes: DIVISION 03 - CONCRETE.
4. Insulation - SECTION 072100 – THERMAL INSULATION
5. Finish Painting: SECTION 099000 - PAINTING.
6. Temporary light and power including payment for energy used shall be by General Contractor. Refer to section 015000-Temporary Facilities and Controls.
7. Automatic Temperature Control: SECTION 230000 - HEATING, VENTILATING, AND AIR CONDITIONING.
8. Door Hardware: SECTION 087100 - DOOR HARDWARE.
9. Communications System Wiring and Equipment: SECTION 270000 – COMMUNICATIONS
10. Commissioning: SECTION 018100 – COMMISSIONING
11. Cutting and patching in masonry construction, and associated lintels: Section 017320 – CUTTING AND PATCHING.
12. Patching of non-masonry construction: Section 017320 – CUTTING AND PATCHING
13. Installation of access doors and frames: Section 083100 – ACCESS DOORS AND FRAMES.
14. Audio Visual Systems wiring and equipment: Section 274100.
15. Auditorium/Stage Dimming Equipment and Theatrical lighting: Section 110640.

1.7 CONTRACT COST BREAKDOWN

A. Submit a breakdown of contract price to aid Architect in determining value of work installed as job progresses.

1.8 INSPECTION OF SITE

A. Electrical bidders will be permitted to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions as they exist.

1.9 CONTRACTOR'S REPRESENTATIVE

A. Retain a competent representative on the project.

1.10 COOPERATION

A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work and proceed in a manner as not to delay progress.

B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.

C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.11 CODES, ORDINANCES, AND PERMITS

A. Codes and Ordinances:
1. All material and work provided shall be in accordance with the following codes and standards as most recently amended.
Commonwealth of Massachusetts Building Code, 8th Edition
Massachusetts Electric Code, 2011 Edition
State Department of Public Safety
NFPA 101 "Life Safety Code"
NFPA Standards
Standards of the Underwriters Laboratories (UL)
Occupational Safety and Health Act (OSHA)
Americans with Disabilities Act (ADA)
Energy Conservation Code
Town of Concord
2. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

B. Permits: Be responsible for filing documents, and securing of inspection and approvals. Pay all permit fees.

C. Utility Company backcharges for permanent service will be paid directly by the Owner. Costs related to temporary service will be paid by General Contractor as noted in Section 015000. Refer to INSTRUCTIONS TO BIDDERS AND SUPPLEMENTARY GENERAL CONDITIONS.

1.12 ELECTRICAL ROOMS OR SPACES

A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Sections 110-16 and 110-26 are maintained for all electrical equipment.

B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

1.13 SUBMITTALS

A. General: Refer to Section 013300 – Submittal Procedures for general requirements for submittal of product data, shop drawings and other materials for review by the Architect and their Consultants.

B. Provide submittals for all products and systems specified herein or specified under other sections but furnished under this section, i.e. access panels.

C. Submit the following samples:
1. Lighting fixtures as may be requested.
2. Other items as may be requested.

1.14 GUARANTEE

A. All parts of the work shall be guaranteed for a period of one (1) year from the date of acceptance of the job by Owner. If during that period of general guaranty, any part of the work fails, becomes unsatisfactory, or does not function properly due to any fault in material or workmanship whether or not manufactured or job built, the Owner shall upon notice from owner promptly proceed to repair or replace such faulty material or workmanship without expense to owner, including cutting, patching, and painting, or other work involved, and including repair or restoration of any damaged sections of the premises resulting from such faults.

B. In the event that a repetition of any one defect occurs indicating the probability of further failure and which can be traced to faulty design, material, or workmanship, then repair or replacement shall not continue to be made but the fault shall be remedied by a complete replacement of the entire defective unit.

C. In addition to the general guaranty, obtain and transmit to owner any guaranties or warranties from manufacturers of specialties, but only as supplementary to the general guaranty which will not be invalidated by same.

1.15 ELECTRICAL CHARACTERISTICS

A. In general, and unless specifically indicated otherwise, all building service, heating, ventilating, air conditioning, and plumbing equipment shall be of the following characteristics:
1. Motors up to and including 1/3 HP shall be suitable for 120 volts, one phase operation.
2. Motors larger than 1/3 HP shall be suitable for 480 volts, three phase operation.
3. Electric heating equipment 4 KW and less shall be suitable for 277 volt single phase operation. Over 4 KW shall be 480 volt three phase.

B. Power Factor: All equipment provided rated greater than 1,000 watts and lighting equipment greater than 15 watts with an inductive reactance load component shall have a power factor of not less than 90% under rated load conditions.

1.16 TEMPORARY & POWER

A. Refer to Section 015000 – Temporary Facilities and Controls.

1.17 INSPECTIONS AND TESTS

A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.

B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels and switchboards shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.

1.18 ENERGY REBATE PROGRAM

A. This project has been designed to incorporate equipment approved for energy rebate such as fixtures, ballasts and lamps. Provide unit prices for each fixture type scheduled to be part of Rebate Program. Assist the Owner in filling out CMLP rebate applications. Provide fixture cut sheets, quantities and controls along with required drawings and information required to complete the Utility Company rebate.

1.19 COMMUNICATIONS SYSTEMS

A. This contractor shall work closely with the Communications Contractor to assure a first class installation. Coordinate all back boxes and conduits required prior to installations. In general, the electrical contractor shall provide conduits from outlets to accessible ceiling space.

B. Responsibilities of the Electrical Sub-Contractor: The Electrical Contractor shall be responsible for furnishing and installing all related system provisions including, but not limited to: 120 volt power, cable trays, conduits with bushings, conduit stubs with bushings, sleeves with bushings (all conduits, stubs, sleeves, etc., shall be brought to an accessible ceiling of the same floor), backboxes, plaster rings, pull strings, bonding, grounding, etc., for a completely operational system, as specified. Specialty backboxes will be furnished by Section 270000 and installed under this section.

C. Responsibilities of the Communications System Contractor (Section 270000): The communications contractor will be responsible for furnishing, installing, wiring, programming, troubleshooting, training and warranty service of all communications cabling, outlets and equipment, for complete operational systems.

1.20 COORDINATION DRAWINGS

A. General: Refer to Section 013100 - Project Management and Coordination for general requirements for the preparation and submittal of coordination drawings.

B. Coordination requirements specific to the Work of this Section include the following:
1. Before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines, pull boxes, etc. relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.

1.21 RECORD DRAWINGS

A. Refer to Section 017830 – Project Record Documents for general requirements for maintenance as-built drawings and submitting final reproducible record documents.

B. Record Drawings for the Work of this Section shall include the following:
1. Provide two (2) sets of black or blue line on white drawings to maintain and submit record drawings, one set shall be maintained at site and which shall be accurate, clear, and complete showing actual location of all equipment as installed. Record drawings shall be updated at least monthly. Record drawings shall show outlet from which homeruns are taken, and location of all junction boxes and access panels. These drawings shall be available to Architect/Engineer field representative.

2. Any addenda sketches and supplementary drawings issued during course of construction shall be attached to drawings.

1.22 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

A. General: Refer to Section 017700 – Close Out Procedures for general requirements for submittal of operations and maintenance manuals, training of personnel and related closeout procedures.

B. Closeout procedures specific to the Work of this Section include the following:
1. Operating Instructions: Furnish operating instructions to Owner's designated representative with respect to operations, functions and maintenance procedures for equipment and systems installed. Cost of such instruction up to a full three (3) days of Electrical Subcontractor's time shall be included in contract. Cost of providing a manufacturer's representative at site for instructional purposes shall also be included.
2. Maintenance Manuals:
   a. At completion of the project, provide four copies of complete manuals containing the following:
      1) Complete shop drawings of equipment.
      2) Operation description of systems.
      3) Names, addresses, and telephone numbers of suppliers of systems.
      4) Vendors' P.O. numbers for equipment installed.
      5) Preventive maintenance instructions for systems.
      6) Spare parts list of system components.
   b. All information shall be in one binder.

1.23 ALTERNATES

A. Refer to Section 01 23 00 for Alternates affecting this section.

B. Include in your bid a separate price for amounts to be added or deducted from base bid amount for the following areas of electrical work:
1. Alternate No. 4 – To be determined.

1.24 PHASING, DEMOLITION AND MAINTAINING EXISTING SERVICES

A. Demolition of Existing Electrical Work:
1. Disconnect all existing materials, fixtures and equipment indicated to be salvaged.
2. Disconnect and cap all existing electrical lines from building as indicated on drawings.

Notify General Contractor when existing fixtures, materials, equipment and other features are ready for removal, salvaging, and disposal under Section 024119 - Demolition.

1.25 QUALITY ASSURANCE

A. Sustainable Goals: The Architect has designed the project to meet the Owner's sustainable goals. Products and systems have been specified which meet certain third-party evaluations or have particular VOC and source requirements. Evaluation of products proposed for substitution will be evaluated based on the Owner's sustainable goals and other criteria included in Division 1. The Contractor is encouraged to use sustainable construction practices, means and methods. Unless specifically stated in a specification section, no sustainable design documentation is required of this Contractor.

1.26 SUSTAINABLE DESIGN INTENT

A. Comply with project requirements intended to achieve the required minimum score, measured and documented according to the Collaborative for High Performance Schools – Massachusetts. Project scores will be verified by a third party certifier.
1. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.27 RETURN AIR PLENUM

A. All wiring systems in areas above hung ceilings that are return air plenums shall either be in conduit or shall be UL Listed Plenum rated cable.

PART 2 - PRODUCTS

2.1 GENERAL

A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.

B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.

C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.

D. Where Specifications list manufacturers' names and/or "as approved" or "Equal approved by Architect", other manufacturers' equipment will be considered if equipment meets Specification requirements and has all features of the specified items as are considered essential by Architect.

E. All material shall be new and shall be UL listed.

2.2 RACEWAYS AND FITTINGS

A. Raceways - General:

1. No raceway shall be used smaller than 3/4" diameter and shall have no more than four (4) 90o bends in any one run, and where necessary, pull boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by "UL" for such use or not.
2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80-1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, and in mechanical rooms for drops down to equipment from elevations below eight feet and also where raceway may be subject to mechanical damage.
3. Intermediate metal conduit conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and may be used for fire alarm work.
5. Surface metal raceways conforming to, and installed in accordance with, Article 386 may be used only where raceways cannot be run concealed, and then, if only specifically approved.
6. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
7. Rigid non-metallic conduit may be used for underground electric and telephone services outside the foundation wall and also below slab and shall be polyvinyl chloride (PVC) schedule 40, 90oC. Rigid metal conduits shall be used thru-foundation walls and thru-slab. Below slab conduits do not require concrete encasement.
8. PVC Schedule 40 may be used for below slab for feeders and circuits within building confines. Below slab rigid non-metallic conduits do not require concrete encasement. Rigid non-metallic conduits may be used for below slab feeders and branch circuits, but shall not be used in slabs, nor for elbows which penetrate slabs. Raceways and fittings shall be produced by same manufacturer.
9. PVC schedule 40 may be used for underground branch circuits and feeders outside the foundation wall.
10. Acceptable manufacturers:
    Pittsburgh Standard Conduit Company
    Republic Steel and Tube
    Youngstown Sheet and Tube Company
    Carlon
11. Electrical non metallic tubing (ENT) conforming to an installed in accordance with Article 362 and conforming to industry standards may be used for A/V and Tel/Data provisions where concealed.
    a. Acceptable manufacturers
        1) KWIKON
        2) Carlon
        3) Plastic Trends
        4) Or Equal
12. Fittings:
    a. Provide insulated bushings on all raceways 1 inch diameter or larger.
    b. Manufacturer's standard fittings shall be used for raceway supports.

c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap. Bond separate buildings in accordance with code.
d. Couplings for rigid metal and intermediate metal conduit shall be threaded type.
e. Threadless fittings for EMT shall be watertight compression type or set-screw type (dry-locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1 inch diameter.
f. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
g. Wall entrance seals shall be equal to O.Z. Gedney type "WSK".
h. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
i. Acceptable manufacturers:
O.Z.
Crouse Hinds
Appleton
EFCOR
Steel City

B. Outlets, Pull and Junction Boxes:
1. Outlets:
a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast-metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted.
b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1-1/2" deep unless shallower boxes are required by structural conditions and are specifically approved by Architect. Ceiling and bracket outlet boxes shall not be less than 4" octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4" square or of comparable volume.
c. Far side box supports shall be Caddy J-1A.
d. Acceptable manufacturers:
Appleton
Crouse Hinds
Steel City
RACO
Or equal
2. Pull and Junction Boxes: Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be as required by Code.
Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4-11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.
a. Acceptable Manufacturers:
Brasch
Hoffman
Keystone
Lee Products Co.

McKinstry Inc.
Eldon Inc.
Or equal

2.3 CONDUCTORS

A. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 80' at 120 volts and 150' at 277 volts, #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:

1.	208Y/120V	Phase A	Black
2.	208Y/120V	Phase B	Red
3.	208Y/120V	Phase C	Blue
4.	480Y/277V	Phase A	Brown
5.	480Y/277V	Phase B	Orange
6.	480Y/277V	Phase C	Yellow
7.	Grounded Conductor		
		120/208	White
		277/480	Grey
8.	Equipment Ground		
		120/208	Green
		277/480	Green with Yellow Trace
9.	Isolated Ground	120/208	Green with Orange Trace

B. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.

C. Connections throughout the entire job shall be made with solderless type devices.
1. For #10 AWG and smaller: spring type.
2. For #8 AWG and larger: circumferential compression type.
3. Acceptable manufacturers:
3M "Scotchlock"
IDEAL "Wingnut"
BURNDY
MAC
Or equal
4. Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type, as manufactured by King Technology, St. Louis, MO.

D. Conductors shall be copper, soft drawn, and annealed of 98% conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:
1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75^{o}C) except as follows:
a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75oC - 90oC) may be used.
b. Fire alarm system conductors shall be #14 AWG, type THHN, solid. Color coding of fire alarm conductors shall be in accordance with fire codes.
c. Fixture whips #16AWG type "SF".

E. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.

F. 2 Hour Fire Rated MC Cable: MC power cable is listed by UL as 2-hour fire-rated when installed in accordance with RSCC installation procedures and system listings. This cable meets the requirements of an "Electrical Circuit Protective System" as referred to in Articles 695 and 700 of the National Electrical Code (NEC). It meets all the electrical and fire-resistive requirement of NFPA 502 and NFPA 130. The details of this system appear in Electrical Circuit Protective System (FHIT), System No .36 of the UL Fire Resistance Directory.
   1. Features:
      a. 1 hour rating per UL 2196.
      b. Low smoke, Halogen free design.
      c. Simple to terminate with commercially available brass MC connectors.
      d. Printed number coating allows for easy circuit identification.
      e. Uses convectional stripping tool.
      f. Available in long lengths.
      g. Welded armor forms an impervious barrier.
      h. Armor is impact & crush resistant.
      i. Fire-rated splice available.
   2. Performance Standards:
      a. UL listed, NEC type MC in accordance with UL Standard 1569.
      b. 2 hour fire rated per UL standard 2196 following ASTM E119 (1,850°F with water hose stream).
      c. Electrical Circuit Protective Systems (FHIT) – System No .36 of the UL Fire Resistive Directory.
      d. Meets and exceeds fire rated cable requirements in NFPA 130 for Transit applications.
      e. Meets and exceeds cable requirements in NFPA 502 for Tunnel applications
      f. Exceeds NEC Article 695 & 700 fire endurance requirements.
      g. Rated FT-4/IEEE 1202 Vertical Flame test; -ST1, limited smoke.
      h. For use in wet locations to 90°C.
      i. Armored with copper sheath that exceeds the NEC requirement for equipment grounding conductor.
      j. Complies with NFPA 130 and 502 total smoke released and low toxicity.
   3. Construction
      a. Conductor: annealed copper, Class "B" strand per ASTM B-3 & B-8.
      b. Insulation: Thermoset, low smoke zero halogen silicone rubber.
      c. Circuit Identification: Printed numbers per ICEA Method 4.
      d. Inner Jacket: Thermoset, low smoke zero halogen silicone rubber.
      e. Armor: Continuously welded and corrugated copper.
      f. Outer Jacket (optional): Black Low Smoke, zero halogen polyolefin.
   4. Approved manufacturer – Vitalink MC, Raychem, Draka USA or equal.

G. Type MC Cable may be used for concealed branch circuits in hollow spaces where allowed by code if installed and terminated as specified under Execution Section. Armor to be galvanized steel and shall be UL listed for 2 hour fire wall penetration. Light steel armor is also acceptable.

H. Type MC Cable may be used for fire alarm where concealed and allowed by Code, armor shall be red.

I. Acceptable manufacturers:

AFC Cable Systems
American Wire & Cable
Cerro
Cornish
Cresent
General Cable

Okonite
Or equal

2.4 ACCESS PANELS

A. General: Furnish access panels for installation by others, at all new and existing construction where required for access to the Work of this Section.

B. Refer to Section 083100 – Access Doors and Frames, for all product requirements for furnishing access panels.

C. Coordinate locations and schedule with the work of trades involved with construction in which access panels will be installed.

2.5 SLEEVES, INSERTS, AND OPENINGS

A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1" above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any unsleeved openings shall be waterproofed.

B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction as required to support raceways and equipment.

C. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Contractor so he may box out opening in form work.

D. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.

Acceptable Manufacturers:

Specified Technologies Inc.
Thomas & Betts
International Protective Coatings Corp.
3M Fire Protection Products
Dow Corning

2.6 FLOOR OUTLETS (FLUSH TYPE)

A. All flush floor outlets shall be Steel City 640 or 840 series cast iron, watertight type. The 640 series shall be used generally, and the 840 series used where shallow depth is required.

B. Whenever floor outlets for different services are indicated in the same location, they shall be ganged together.

C. Covers shall be brass series P64. Duplex receptacle and low tension covers shall be lift lid type P64DS. Flush floor outlets located in carpeted areas shall be provided with P64-CP carpet plates of the number of gangs required.

D. Refer to drawing for specific floor boxes in special areas such as Media Center, Auditorium, etc.

2.7 WIRING DEVICES

A. Receptacles: Receptacles shall be flush mounted. All standard 20 ampere devices to be of same manufacturer.

Acceptable Manufacturers:

Twenty (20) ampere duplex grounding type NEMA 5-20R,
Cooper 5362-V,
Hubbell 5362I,
Pass and Seymour 53621,
Leviton 5362-I
Or equal

Thirty (30) ampere, 250 volt NEMA 14-30R complete with plate,
Cooper 1257,
Hubbell 9350,
Pass and Seymour 3853
GE 1439-3
Or equal

B. Switches: 20 ampere,
Cooper CWD 2221,
Hubbell 1221,
Pass and Seymour 20AC-2,
Leviton 1221.
GE 5951
Or equal
Prewired devices with pigtails acceptable

C. Composition material of wiring devices to be nylon with white finish. Outlets intended for computer use shall be grey finish.

D. Coverplates: Brushed US 302 stainless steel.

E. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces and exterior walls.

F. Dimmer Controls (Refer to Stage Lighting for specific stage lighting controls):
1. All devices shall be UL listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage, electronic low voltage). Manufacturer shall provide file card upon request. Universal dimmers are not acceptable.
2. All dimmers and switches shall incorporate an air gap switch. The air gap switch shall be capable of meeting all applicable requirements of UL 20 for air gap switches on incandescent dimmers.
3. All dimmers and switches shall provide power- failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
4. Dimmers and switches shall met ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
5. Dimmers and switches shall meet the UL 20 limited short circuit test requirement for snap switches.
6. Dimmer shall provide a smooth and continuous Square Law dimming curve.

7. Dimmers shall be voltage regulated so that +10% variation in line voltage shall cause not more than + 5% variation in load voltage when dimmer is operating at 40V (5% light output).
8. Dimmers, where ganged, shall be derated in accordance with manufacturer's instructions. Ratings in watts listed on the drawings are the derated ratings.
9. Dimmers shall be Lutron, Leviton, Lightolier or equal.

G. Exterior Outlets with Lockable Covers:
1. Provide exterior outlets with lockable covers at all exterior outlet locations. Provide GFCI Circuit Breakers on all branch circuits. Provide in-use flush mounted weatherproof locking covers.

2.8 LIGHTING FIXTURES

A. General

1. Submit the following in accordance with project submittal procedures:

a. Catalog Data: Submit catalog data describing luminaires, lamps, and ballasts. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of fixture designation.
b. Performance Curves/Data:

1) Submit certified photometric data for each type of luminaire.
2) Submit supply-air, return-air, heat-removal, and sound performance data for air handling luminaires.

c. Drawings: Submit shop drawings for non-standard luminaires.
d. Calculations: Submit as requested to support equal product proposals..
e. Warranty: Submit warranties for luminaires and for electronic ballasts.

2. All lamps, ballasts, led sources, drivers, and controls shall meet the latest utility company incentive requirements. Refer to the latest program requirements documentation and coordinate with the utility company to ensure compliance.

B. Quality Assurance

1. Comply with the National Electrical Code (NEC) and the Massachusetts Building Code (MBC) for components and installation.
2. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.
3. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.
4. Coordinate luminaires, mounting hardware and trim with the ceiling system.

C. Lamps

1. Furnish lamps that comply with requirements specified below and the luminaire schedule on the Drawings.
2. Compact fluorescent lamps shall have kelvin color temperature as scheduled with a color rendering index of 82 minimum. Compact fluorescent lamps shall be the amalgam type, Sylvania Dulux T/E/IN or equal by Philips or GE.

3. Linear fluorescent lamps shall have kelvin color temperature as scheduled with a color rendering index of 85 minimum. T5ho lamps shall be the energy saver type, Sylvania Pentron HO Supersaver Ecologic or equal by Philips or GE. All T5 lamps shall be the energy saver type, Sylvania Pentron Supersaver Ecologic or equal by Philips or GE.

D. Ballasts

1. Standard compact fluorescent ballasts shall be Sylvania Quicktronic Prostart CF series or equal by Advance, GE, or Universal.
2. Dimming compact fluorescent ballasts shall be Sylvania Quicktronic Helios CF series (0-10v) or equal by Advance, GE, or Lutron.
3. Standard T5 and T5HO linear fluorescent ballasts shall be high efficiency type, Sylvania QHE Prostart series or equal by Advance, GE, or Universal.
4. Dimming linear fluorescent ballasts (0-10v) shall be Sylvania Quicktronic Powersense (T5) series or Sylvania Quicktronic Helios (T5HO) series or equal by Advance, GE, or Lutron.
5. Three and four lamp luminaires shall have two ballasts per luminaire for multilevel switching.
6. Provide NRTL-listed luminaire disconnect assembly for each ballast. Manufacturer: IDEAL “PowerPlug”, Thomas & Betts “Sta-Con.”

E. LED Assemblies

1. LED luminaires shall conform to UL 1598 and to UL 8250 – Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products.
2. Products shall be lead and mercury free.
3. Photometric characteristics shall be established using IESNA LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products.
4. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – Specifications for the Chromaticity of Solid State Lighting Products.
5. LED and driver cooling system shall be passive and shall resist the buildup of debris.
6. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources.
7. LED source package electrical characteristics:

    a. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
    b. Total harmonic distortion (current): Not more than 10 percent
    c. Power factor: Not less than 90%
    d. RF interference: Meet FCC 47 CFR Part 15/18
    e. Transient protection: IEEE C62.41 Class A.

F. Extra Materials

1. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.

    a. Five (ten percent of quantity of fluorescent lamps of each type, but no fewer than two lamps of each type).
    b. Five (five percent of quantity of LED source packages of each type, but no fewer than two of each type).

c. One (two percent of quantity of louvers and lenses of each type, but not less than one of each type).
d. One (two percent of quantity of ballasts of each type, but not less than one of each type).
e. One (two percent of quantity of LED drivers of each type, but not less than one of each type).

G. Interior General:

1. Furnish interior luminaries that comply with requirements specified below, indicated on the Drawings, and as required to meet conditions of installation.
2. Metal parts shall be free from burrs and sharp corners and edges.
3. Metal components shall be formed and supported to prevent sagging and warping.
4. Steel parts shall be finished with manufacturer's standard finish applied over a corrosion-resistant primer. Finish shall be free from runs, streaks, stains, holidays or defects.
5. Doors and frames shall be smooth operating and free from light leakage under operating conditions. Relamping shall be possible without the use of tools. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
6. Luminaires shall have minimum reflecting surface reflectance as follows unless specified otherwise on the Drawings:

   a. White Surfaces: 85 percent
   b. Specular Surfaces: 83 percent
   c. Diffusing Specular Surfaces: 75 percent

7. Lenses, diffusers, covers and globes shall be 100 percent virgin acrylic unless specified otherwise on the Drawings. Lenses shall have 0.125 inches minimum thickness. Lenses for fluorescent troffers shall be injection molded.
8. Luminaires shall conform to UL 1598 - *Luminaires*. Provide product with damp location listing or wet location listing as required by installation location.

H. Interior Accessories

1. Provide stud supports, mounting brackets, frames, plaster rings and other accessories required for luminaire installation.
2. Furnish hangers as specified below and as required by conditions of installation:

   a. Stem hangers shall be made of 1/2-inch steel tubing with 45 degrees swivel ball hanger fitting and ceiling canopy. Finish the same as the luminaire.
   b. Rod hangers shall be made of 1/4 inch threaded zinc-plated steel rod.
   c. For HID luminaires provide hook hangers that are integrated assemblies matched to the luminaire and line voltage; equip with threaded attachment, power cord and locking type plug. Provide a safety chain or cable for each luminaire that will attach to the building structure, the ballast housing, and to the reflector/diffuser assembly.

3. Use NRTL-listed T-bar safety clips for lay-in fluorescent luminaires.
4. Where indicated on the Drawings or where lamp breakage is detrimental, such as above food counters, provide open fluorescent luminaires with:

   a. Self-locking sockets or lamp retainers, two per lamp, and
   b. Clear polycarbonate protective lamp sleeves with end caps over each lamp. Sleeve shall have a light transmission of 95 percent and shall be rated for the thermal profile of the lamp and ballast.

I. Interior Installation

1. Install interior lighting system in accordance with the NEC, manufacturer's installation instructions, approved shop drawings, and NECA National Electrical Installation Standards.
2. Have the manufacturer’s installation instructions available at the Project site.
3. Mounting heights specified or indicated on the Drawings are to the bottom of the luminaire for ceiling-mounted fixtures and to the center of the luminaire for wall-mounted fixtures.
4. Where the ceiling forms the protective membrane of a fire resistive assembly, install protective coverings over luminaires in accordance with NRTL requirements.
5. Install slack safety wires as described below for luminaires in or on suspended ceilings.

    a. Wire shall be minimum 12 gage galvanized soft annealed steel wire conforming to ASTM A641.
    b. Attach wire to the building structure directly above the attachment point on the box or luminaire; make trapezes of framing channel material as required to span obstacles
    c. Secure wire(s) at each end with not less than three tight turns in 1-1/2 inches.

6. Support pendant-mounted or cable-supported luminaires directly from the structure above using a 9 gage wire or an approved alternate support without using the ceiling suspension system for direct support.

    a. Install seismic restraints for pendant-mounted and cable-supported luminaires.
    b. Pendants, rods, cables, or chains 4 ft or longer shall be braced to prevent swaying using three cables at 120 degrees separation.

7. Connect luminaires in suspended ceilings using 6 ft. lengths of flexible wiring method arranged accommodate not lea than 4 inches of differential seismic movement in any direction.

J. Interior Quality Control

1. Make electrical connections, clean interiors and exteriors of luminaires, install lamps, energize and test luminaires, inspect interior lighting system, and deliver spare parts in accordance with manufacturer's instructions and NECA National Electrical Installation Standards:
2. Test electronic dimming ballasts for full range dimming capability.
    a. Burn-in dimmer controlled fluorescent lamps at full output for not less than 100 hours before dimming.
    b. Check for visually detectable flicker over the full dimming range.

3. Prior to turnover to Owner, replace lamps that were installed and used during construction if more than 15 percent of their rated lamp life has been used.

K. Exterior - General

1. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
2. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
3. Luminaire housing shall be primarily metal.

    a. Metal parts shall be free from burrs and sharp corners and edges.

b. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
c. Exposed fasteners shall be stainless steel.

4. Doors and frames shall be smooth operating and free from light leakage under operating conditions.

a. Relamping shall be possible without the use of special tools.
b. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
c. Door shall be removable for cleaning or replacing lens.

5. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:

a. White surfaces: 85 percent
b. Specular surfaces: 83 percent
c. Diffusing specular surfaces: 75 percent

6. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
7. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

L. Exterior Poles and Accessories

1. Furnish poles and accessories that comply with requirements specified in this Section and the luminaire schedule on the Drawings.
2. Pole, base, and anchorage shall carry the luminaires, supports, and appurtenances at the indicated height above grade without deflection or whipping.
3. Mountings, fastenings and other appurtenances shall be fabricated from corrosion-resistant materials that are compatible with poles and luminaires and will not cause galvanic action at contact points. Mountings shall correctly position luminaires to provide scheduled light distribution.
4. A reinforced access handhole shall be located in the wall of each metal pole.
5. A welded 1/2 inch grounding lug shall be accessible through the handhole of each metal pole. Grounding connection shall be designed to prevent electrolysis when used with copper ground wire.
6. Metal poles shall have anchor type bases and galvanized steel anchor bolts and leveling nuts.
7. Metal poles shall have a metal base cover that covers the entire base plate and anchorage.
8. Protect painted, anodized, or brushed pole finishes during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.
9. Aluminum poles shall be fabricated from corrosion resistant aluminum Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys or Alloy 356-T4 for cast alloys.

a. Poles shall be square or round, tapered or straight as indicated on the Drawings.
b. Aluminum poles over 30 feet tall shall include factory-installed vibration dampers.
c. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness.
d. Tops of shafts shall be fitted with a round or tapered cover.

e. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M, Standard Specification for Aluminum-Alloy Permanent Mold Castings and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded.
f. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.

10. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi. The top 12 inches of the anchor bolt shall be galvanized in accordance with ASTM A153/A153M.
11. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.
12. Fuses and Fuse holders

    a. Furnish fuse overcurrent protection for each pole-mounted luminaire to isolate faulted ballasts from the lighting circuit.
    b. Use 600 volt, Class CC, time-delay, current-limiting fuses.
    c. Select fuses rated between 200% and 300% of the luminaire ballast or driver maximum current.
    d. Manufacturer: Bussman “LP-CC” or approved equal.

13. Furnish in-line fuse holders for installation in pole hand hole or transformer base.

    a. Use non-breakaway type fuse holders unless breakaway poles are indicated on the Drawings.
    b. Use breakaway type fuse holders where breakaway poles are indicated on the Drawings.
    c. Load and line terminal sizes and types shall correspond to line and load conductor sizes and quantities.
    d. Both breakaway and non-breakaway fuse holders shall have insulating boots.
    e. Manufacturers: Ferraz Shawmut “FEC” for phase conductor(s), “FEBN” for neutral conductor, or approved equal.

M. Exterior Installation

1. Install products in accordance with manufacturer's instructions, NECA/IESNA 501, and approved shop drawings.
2. Locations of luminaires and poles shown on the Drawings are diagrammatic. Coordinate luminaire locations with building finishes, building structure, paving and striping, utility piping, security fences, and existing trees. Obtain approval for location changes through LANL Subcontract Technical Representative (STR).
3. Set poles and luminaires plumb, square, level and secure.
4. Install surface mounted luminaires directly to an outlet box which is supported from structure.
5. Install in-grade luminaires flush with surrounding surface. Coordinate pitch or grading of surface with General Contractor to allow drainage away from fixture.
6. Install lamps in luminaires in accordance with manufacturer's instructions.
7. Concrete Foundations:

    a. Construct concrete foundations with exterior 4000 psi concrete and reinforcing conforming to Section 033001 – CAST-IN-PLACE CONCRETE – SIT WORK.
    b. Comply with details on the Drawings and manufacturer's recommendations for foundation dimensions, reinforcing, anchor bolts, nuts and washers.
    c. Position power conduits and ground rod to terminate within the pole shaft area and one inch above the top of the foundation.
    d. Cure concrete foundations for 7 full curing days before erecting poles.

8. Pole Erection

   a. Do not install poles without luminaires.
   b. Use fabric web slings to raise and set poles.
   c. Use leveling nuts or shims to make poles plumb. When leveling nuts are used, set the lower nuts not more than 1 inch from the concrete foundation.
   d. Tighten anchor bolt nuts and other pole hardware to torque recommended by manufacturer.
   e. After pole is leveled, pack non-shrink grout between anchor base and concrete foundation to provide a full bearing surface. Use a short piece of 1/2-inch diameter pipe to make a drain hole through grout; arrange to drain condensation from interior of pole.
   f. Set embedded poles to depth indicated on the Drawings, but not less than 1/6 of pole length below finish grade.
   g. Auger holes large enough to permit the use of tampers the full depth of the hole.
   h. Backfill in 6 inch layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of the undisturbed earth.

2.9 ELECTRICAL POWER EQUIPMENT

A. Motor Controls - Manual and Solid State:
   1. Individually-mounted starters shall be NEMA rated solid state type with thermal overload on each reduced voltage start.
   2. Motor Starters shall be furnished by Electrical Sub-Contractor unless part of package mechanical equipment such as rooftop units. Refer to equipment schedules on Electrical Plans and provide accordingly.
   3. The solid state motor controller shall use silicon controlled rectifiers (SCR's) to control the voltage to the motor windings. Two SCR's shall be used in a back-to-back arrangement in each phase to allow alternating current to pass to the motor. When SCR triggering is delayed, the voltage to the load shall be reduced. This phase-controlled operation provides soft starting with step-less acceleration. Once the motor is running, voltage reduction can improve the motor's operating point at partial load, saving energy and lowering the reactive current. If one or more shorted SCRs are detected, the starter shall not energize. A fault LED will light and if provided with a shunt trip, the main circuit breaker will trip. Provide pump stop option to eliminate water hammer in pumping systems, by giving a controlled decel to the motor voltage. This process shall allow for smooth pressure reduction and quiet check valve operation. The controller shall trip off the line if one or more phases are lost.
   4. Starters shall be of size and type required for particular motor horsepower and voltage. Minimum size starter to be size 1 FVNR, unless noted otherwise.
      a. Starters shall have OL reset button, green push-to-test type pilot light to indicate "ON", and "HAND-OFF-AUTO" switch in cover.
      b. Starters to have 120 volt control transformers with fused output being provided for those units operating on 277/480 volt system.
      c. Provide Class 20 fixed heater overloads with auto/manual reset.
      d. Provide four (4) sets of auxiliary contacts of convertible type N.O. to N.C. for each starter.
      e. Motor starters shall have NEMA I enclosures. Those in wet locations shall be NEMA 3R.
      f. Acceptable Manufacturers:

         Westinghouse/Culter-Hammer
         Square D/Groupe Schneider
         Siemens

Allen Bradley
GE
Or equal

5. Manual motor starters shall have pilot lights and shall be furnished with thermal overloads on each phase.

B. Motors: Each motor shall have disconnect switch and starter provided under this section.

C. Provide motor terminal boxes for each motor not furnished with same.

D. Disconnect Switches:
1. Disconnect (safety) switches shall conform to industrial standards of NEMA, be UL listed and shall be heavy duty type, quick-make, quick-break type with interlocking cover mechanism and provisions for padlocking switch handle in "OFF" position. Three pole toggle switches are not acceptable as substitute for disconnect switches.
2. Disconnect switches shall be of fused or unfused type as indicated with number of disconnecting poles indicated. The grounded conductor shall not be switched. Switches for use with current limiting fuses shall be rejection type and those used in conjunction with motors shall be horsepower rated. Provide oversize termination lugs if required by conductor size.
3. Enclosures shall be of proper NEMA type for intended location and shall be phosphate coated or equivalent code gauge galvanized sheet steel with ANSI #24 dark gray baked enamel finish.
4. Acceptable Manufacturers:

Westinghouse/Cutler-Hammer
Square D/Groupe Schneider
Siemens
Allen Bradley
Or equal

E. Fuses:
1. Provide a complete set of fuses for each item of fusible type equipment.
2. Turn over to authorized representative of Owner upon completion a spare set of fuses of each different type and ampere rating installed. These spares shall be bound with twine and tagged.
3. Secondary system fuses, rated at 600 volts or less, shall be UL listed and constructed in conformance with the applicable standards set forth by NEMA and ANSI. All fuses of a particular class shall be of same manufacturer.
4. All fuses in distribution panelboards and switchboards shall be class "L" above 600 amperes and class "RK1" for 600 amperes and below.
5. Main, Feeder, and Branch Circuits:
   a. Circuits 601 amperes and above shall be protected by (Bussmann type KRP-C LOW-PEAK) current limiting time delay fuses.
   b. Circuits 0-600 amperes shall be protected by (Bussmann "LOW-PEAK" dual element), time delay current limiting fuses, LPN-RK (250 volts), LPS-RK (600 volts), UL class RK-1.
6. Acceptable Manufacturers:
Bussmann, Division of McGraw
Gould/Shawmut
GEC-ALSTHOM
Or equal

2.10 ELECTRICAL SYSTEM CONTROLS AND INSTRUMENTS

A. Provide a complete power system consisting of branch circuits, motor disconnect switches, pushbutton stations, motor starters, and other devices to connect up and leave in operating condition each piece of electrically operated equipment provided either under this section or other Divisions.

B. All control wiring, not indicated in the electrical specifications or not shown on electrical drawings, will be provided by Temperature Control Subcontractor.

2.11 GROUNDING SYSTEM

A. All equipment and systems shall be grounded. Refer especially to NEC Section 250 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding in accordance with utility company standards.

B. The grounded conductor shall be supplemented by an equipment grounding system.

C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.

D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.

E. Maximum measured resistance to ground of 5.0 ohms shall not be exceeded. Ground separately derived systems (dry type transformers) in accordance with Article 250-26 by grounding neutral to transformer ground lug and providing insulated grounding electrode conductor to nearest effectively grounded building steel or, if unavailable, to nearest available effectively grounded metal water pipe.

F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250.

G. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.

H. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable system or non-metallic raceway system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.

I. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal-to-metal continuity.

J. Continuity between all metallic and non-metallic raceway systems and equipment shall be maintained.

K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.

L. Refer to Technology Specifications for additional grounding requirements.

2.12 MAIN BUILDING SWITCHBOARD

A. Main building switchboard shall be constructed in accordance with UL 891 and ANSI standards and of the required number of vertical sections bolted together to form one metal enclosed rigid structure. The sides, top, and rear shall be covered with removable plates. Switchboard shall include all protective services and equipment as listed on drawings with necessary interconnections, instrumentation, and control wiring. Buses shall be copper. Provide oversize termination lugs for any terminations requiring same due to conductor sizing.

B. Record drawings shall be furnished providing the following: Complete rating, short-circuit withstand ability of bus and of lowest rated device, overall outline dimensions, including space available for raceways, circuit schedule showing circuit number, device description, device fuse clip ampere rating, conductor ratings and one-line diagram with each circuit device numbered.

C. Each section shall be 90" high, self-supported, and same depth as incoming line section, approximately 36" deep. Main protective device shall be individually mounted with front coverplate and bus connection straps. Where called for on schedule, "space" shall mean to include necessary bus, supports, and connections, leaving out only the breaker itself. Bus structure shall be arranged to permit future additions.

D. Switchboard shall be arranged for operation as follows:

Voltage - 480Y/277 volts
Frequency - 60 cycles
Service - 3 phase, 4 wire, ampere capacity as indicated on drawings.
Neutral - full capacity
Available short circuit current at line terminals - 65,000 RMS amperes symmetrical.
Integrated equipment rating - 65,000 AIC
Copper ground bus, full length
UL service entrance label

E. The main shall have solid-state trip device (100% rated) sealed with the following features:

Adjustable ampere setting between 50-100% rating
Adjustable long time delay
Adjustable short time pickup
Adjustable short time delay
Fixed instantaneous at 15 times rating
Adjustable ground fault pickup
Adjustable ground fault delay

F. Provide electrical metering and voltage protection system equal to Square D Power Logic, Westinghouse IQ Data Plus or Siemens 4700 Series at main breaker.

G. Branch Devices shall be standard molded case circuit breakers, current limiting circuit breakers, or other devices as scheduled. Branch devices shall be mounted in panelboard type construction.

H. Coordinate with local utility company and include space and provisions for utility company metering if required by the utility company. Refer to electric service section of this Division.

I. Acceptable Manufacturers:

Square D/Groupe Schneider
Cutler-Hammer/Westinghouse

Siemens
General Electric
Or equal

2.13 PANELBOARDS

A. Panelboards shall be dead-front, door in door safety type equipped with single or multi-pole circuit breakers suitable for 120/208 volt or 277/480 volt, 3 phase, 4 wire operation.

B. Buses shall be copper. Panelboards shall have a circuit directory card mounted in a frame with plastic cover on inside of door. Panelboards to have a copper ground bus with terminals for each circuit. Panelboards serving isolated ground receptacles shall have a separate ground bus for terminations of the isolated grounds. The isolated ground bus shall be mounted to the panel tub via non-conducting means with a separate grounding conductor run to the normal panel ground bus. Provide oversize lugs for any termination requiring same due to oversize conductors. Provide 200 percent neutral buses on all 120/208 volt panelboards fed from K13 rated transformers.

C. Cabinets shall be minimum of 20 inches wide and be made of code gauge steel. Surface type shall be ordered without knockouts.

D. Trims shall be made of code gauge steel, surface or flush as indicated. Panelboards shall be keyed alike. Trims shall be provided with full length piano hinge on one side, and secured to tub with sufficient quantity of latches opposite the hinge side to allow trim to fit flush with tub and when released, allow full access to wiring gutters. Inner door shall allow access to circuit breakers only.

E. Panelboards shall be of the following types with minimum circuit breaker frame sizes listed below. Refer to schedules for larger circuit breaker frame sizes due to fault current availability.

1. 120/208 volt, three phase, four wire. Symmetrical interrupting capacity 10,000 AIC.

	Style
Cutler-Hammer type PRL-1	BAB Breakers (bolt-on)
Square D type NQOD	QOB Breakers (bolt-on)
Siemens type CDP-7	BQ Breakers (bolt-on)
General Electric Type AQ	HHQB Breakers (bolt-on)

2. 277/480 volt, three phase, four wire. Symmetrical interrupting capacity 65,000 AIC.

	Style
Cutler-Hammer type PRL-2	GHB Breakers (bolt-on)
Square D type NEHB	EHB Breakers (bolt-on)
Siemens type CDP-7	BQCH Breakers (bolt-on)

General Electric Type AE	TEY Breakers (bold-on)

3. Distribution Panels:
   a. Where scheduled as circuit breaker type, symmetrical interrupting capacity 65,000 AIC.

Cutler-Hammer Type PRL-3	FD Breakers
Square D I-Line type	FA Breakers
Siemens SPP	FXD6 Breakers
General Electrical Spectra	THED Breakers

F. Panelboards and distribution panels shall be of same manufacturer as switchboard. Refer to drawings where higher interrupting are required.

G. All power panels fed from K-13 transformers shall have integral surge protective device within panel board or externally mounted with 60A breaker.

2.14 DRY-TYPE TRANSFORMERS

A. Transformer Specification

1. Compatibility: This product must facilitate the ability of the electrical system to supply a sinusoidal voltage in order to improve the long-term compatibility of the electrical system with all types of linear and nonlinear connected loads today and in the future. All national and international standards on harmonics and power quality set limits on levels of voltage distortion to maintain compatibility.
2. Copper-wound, 3-phase, common core, ventilated, dry-type, isolation transformer built to NEMA ST20 and relevant NEMA, UL and IEEE standards; 200% rated neutral; 60Hz rated; Transformers 750 kVA and less, 600 volt primary and less, shall be U.L. and CSA Listed and bear the label. All terminals, including those for changing taps, must be readily accessible by removing a front cover plate. Windings shall be continuous with terminations brazed or welded. 10kV BIL.
3. Insulation System:
   a. Shall be NOMEX-based with an Epoxy Co-polymer impregnant for lowest environmental impact, long term reliability and long life expectancy
   b. Class: 220 degrees C
   c. Impregnant Properties for low emissions during manufacturing, highest reliability and life expectancy
   d. Epoxy co-polymer
   e. VOC: less than 1.65 lbs/gal (low emissions during manufacturing)
   f. Water absorption (24hrs @25C): less than 0.05% (superior insulation, longer life)
   g. Chemical Resistance: Must have documented excellent performance rating by supplier
   h. Dielectric Strength: minimum of 3200 volts/mil dry (for superior stress, overvoltage tolerance)
   i. Dissipation Factor: max. 0.02 @25C to reduce aging of insulation, extending useful life
4. Operating Temperature Rise: 130 degree C in a 40 degree C maximum ambient
5. Noise levels:
   a. Per NEMA ST-20
   b. Production Test every unit. Data to be available upon request.
6. UL Listed & Labeled K-Rating: K-7 or higher

7. Maximum No Load Losses

    a. Transformers are energized 24 hours a day for their entire life, potentially 40 years or more. These losses are incurred whether the transformer is loaded or not, and cost the user many times the purchase price of the transformer even at current energy rates.
    b. No load losses shall not exceed: 15kVA: 60W, 30kVA: 99W, 45kVA: 130W, 75kVA: 180W, 112.5kVA: 260W, 150kVA: 330W, 225kVA: 450W, 300kVA: 560W, 500kVA: 850W

8. Efficiency at 15% loading
    a. Data shows that transformers are typically very lightly loaded for extended periods of time, therefore to minimize operating cost under real world loading conditions, efficiency at 1/6 loading shall be maximized.
    b. Efficiency at 1/6 load shall meet or exceed: 15kVA: 97.3%, 30kVA: 97.6%, 45kVA: 97.9%, 75kVA: 98.2%, 112.5kVA: 98.4%, 150kVA: 98.5%, 225kVA: 98.6%, 300kVA: 98.7%, 500kVA: 98.8%, 750kVA: 98.9%

9. DOE 10 CFR Part 430 CSL 3 Efficiency requirement, tested per NEMA TP-2:
    a. Shall meet or exceed: 15kVA: 97.6%, 30kVA: 98.1%, 45kVA: 98.3%, 75kVA: 98.6%, 112.5kVA: 98.8%, 150kVA: 98.9%, 225kVA: 98.9%, 300kVA: 99.0%, 500kVA: 99.1%, 750kVA: 99.2%

10. Efficiency under k-7 nonlinear load at 50% of nameplate rating:
    a. 15kVA: 97.3%, 30kVA: 97.7%, 45kVA: 97.9%, 75kVA: 98.4%, 112.5kVA: 98.7%, 150kVA: 98.8%, 225kVA: 98.8%, 300kVA: 98.8%, 500kVA: 98.9%, 750kVA: 98.9%

11. Voltage Taps: For transformers 30kVA-300kVA, provide two 2-1/2% full capacity taps above and below nominal primary voltage. For transformers 15kVA and smaller as well as 500kVA and larger provide one 5% full capacity tap above and below nominal primary voltage.
12. Impedance: Between 3.5% and 5.8% unless otherwise noted.
13. Enclosure type: Ventilated NEMA 2, drip-proof [optional NEMA 3R]
14. Maximum Footprint for 130 degree C rise model in a NEMA 1 enclosure:
    a. 17” Wide x 17” Deep x 27” High for 15kVA.
    b. 26” Wide x 18” Deep x 30” High for 30kVA, 45kVA
    c. 33” Wide x 22” Deep x 40” High for 75kVA, 112.5kVA
    d. 38” Wide x 28” Deep x 52” High for 150kVA
    e. 38” Wide x 32” Deep x 52” High for 225kVA, 300kVA
    f. 52” Wide x 38” Deep x 61” High for 500kVA
    g. 63” Wide x 46” Deep x 67” High for 750kVA

B. Transformer Features
1. Electrostatic Shield: Each winding shall be independently single shielded with a full-width copper electrostatic shield.
2. Transformer shall meet Department of Energy CSL3 efficiency.

C. Acceptable Manufacturers
1. Powersmiths International Corp. or equal.
2. Model ESAVER-C3H for K-7 and over.
3. Model ESAVER–C3L for under K-7.
4. Square D, Acme, and Jefferson Electric are considered equals.

2.15 ELECTRIC SERVICE

A. Coordinate and cooperate with Concord Municipal Light Plant (CMLP), hereinafter called utility company, with respect to providing service and metering.

B. Provide primary manholes, system raceways, elbows, pull wires, transformer foundation pad and all pad grounding. Utility company will provide pad mounted transformer and primary conductors including making up of all terminations and connections.

C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversize lugs if required due to conductor sizing. Attachment of secondary conductors to the transformer terminals will be done by utility company.

D. General Contractor shall do all excavation and back filling in accordance with utility company standards.

E. All work to be done in accordance with utility company standards.

F. Metering: All usage will be on one secondary meter. Utility Company will furnish current transformers and potential transformers to be installed in switchboard. Provide meter socket and locate on exterior of building. Meter will be by Utility Company.

2.16 FIRE ALARM AND DETECTION SYSTEM (Voice evacuation required)

A. Description:
1. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.
2. The fire alarm system shall comply with requirements of latest NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
3. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
4. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).
5. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.
6. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication
7. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

B. Scope:
1. An intelligent reporting, microprocessor controlled fire detection and system shall be installed in accordance with the specifications and drawings.
2. Basic Performance:
   a. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 7 (Class A) Signaling Line Circuits (SLC).
   b. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).
   c. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
   d. Digitized electronic signals shall employ check digits or multiple polling.

e. Power for initiating devices and notification appliances must be from the main fire alarm control panel, the transponder to which they are connected or to a Field Charging Power Supply (FCPS).
f. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
g. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

3. Basic System Functional Operation: When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
   a. The FACP alarm LED on the FACP shall flash.
   b. A local piezo-electric signal in the FACP control panel shall sound.
   c. The 80-character LCD display on the local FACP node and on the intelligent network display shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
   d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
   e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.
4. Software Modifications:
   a. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
   b. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
5. Certifications:
   a. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.

C. Applicable Publications:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

1. National Fire Protection Association (NFPA) - USA:

   No. 72 National Fire Alarm Code
   No. 70 National Electric Code
   No. 101 Life Safety Code

2. Underwriters Laboratories Inc. (UL) - USA:

   No. 50 Cabinets and Boxes

No. 268 Smoke Detectors for Fire Protective Signaling Systems

No. 864 Control Units for Fire Protective Signaling Systems

No. 268A Smoke Detectors for Duct Applications

No. 521 Heat Detectors for Fire Protective Signaling Systems

No. 228 Door Closers-Holders for Fire Protective Signaling Systems

No. 464 Audible Signaling Appliances

No. 38 Manually Actuated Signaling Boxes

No. 346 Waterflow Indicators for Fire Protective Signaling Systems

No. 1481 Power supplies for Fire Protective Signaling Systems

No. 1076 Control Units for Burglar Alarm Proprietary Protective Signaling Systems

No. 1971 Visual Notification Appliances

3. Local and State Building Codes.
4. All requirements of the Authority Having Jurisdiction (AHJ).

D. Approvals:
1. The system must have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc.
FM Factory Mutual
MEA Material Equipment Acceptance (NYC)
CSFM California State Fire Marshal

2. The fire alarm control panel shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels which may require return to the manufacturer for system upgrades, and are not acceptable.

E. Equipment and Material - General:
1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

2. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

F. Conduit and Wire:
1. Conduit:
   a. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
   b. All wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
   c. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
   d. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
   e. Conduit shall not enter any FACP, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
   f. Conduit shall be 3/4 inch (19.1 mm) minimum.
2. Wire:
   a. All fire alarm system wiring must be new, unless specified herein.
   b. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.32 mm) for notification appliance circuits.
   c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
   d. Wiring used for the SLC multiplex communication loop shall be twisted and shielded unless specifically accepted by the fire alarm equipment manufacturer.
   e. All field wiring shall be completely supervised.
3. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for the intended purpose.
4. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
5. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution Panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The FACP cabinet shall be grounded securely to either a cold water pipe or grounding rod.

G. Fire Alarm Control Panel and Fire Command Center:
   1. Fire alarm control panel shall be NOTIFIER Model No. NFS3030, Edward EST3, Simplex 4100ES, Siemens XLS, FCI FC7180 or equal. FACP shall contain a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, transponders, local and remote operator terminals, printers, annunciators, and other system controlled devices.
   2. Node Capacity and General Operation:
      a. Each node shall provide, or be capable of, expansion to 198 intelligent addressable devices per loop plus 2048 annunciation points per system. FACP shall support a minimum of 10 intelligent loops.
      b. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
      c. All programming or editing of the existing programming the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
      d. The system shall include emergency voice communications utilizing distributed amplification and intelligence such that loss of operation by the main FACP will not result in the loss of evacuation signal throughout the balance of the building.
      e. Each FACP node shall provide the following features:

Block Acknowledge	Printer Interface
Charger rate Control Interface	CRT Display
Control-by-Time	Non-Alarm Module Reporting
Day/Night Sensitivity	Periodic Detector Test
Device Blink Control	Remote Page
Drift Compensation	Trouble Reminder
NFPA 72, Sensitivity Test	Upload/Download to PC computer
System Status Reports Counters	Verification
Security Monitor Points	Walk Test
Alarm Verification	Maintenance Alert

   3. Loop Interface Board (LIB):
      a. Loop interface boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop interface board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.
      b. The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.

c. The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 4, Style 6, or Style 7.
d. The LIB shall be able to drive two Style 4 SLC loops, each up to 10,000 feet in length, for an effective loop span of 20,000 feet.
e. The loop interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.
f. The LIB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status. Communication with up to 198 intelligent devices shall be performed every 6 seconds or less.

4. Enclosures:
   a. Control panels shall be housed in UL listed cabinets suitable for semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish.
   b. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
   c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
   d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.
5. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.
6. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems, which require use of external programmers or change of EPROM’s are not acceptable.
7. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.
8. FACP Power Supplies:
   a. Main power supplies shall operate on 120 VAC, 60Hz, and shall provide all necessary power for the FACP.
   b. Each main supply shall provide 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.
   c. The main power supply shall be expandable for additional notification appliance power in 3.0 ampere steps.
   d. Each main power supply shall provide a battery charger for 60 hours of standby using dual-rate charging techniques for fast battery recharge. It shall charge 55 Amp hour batteries with-in a 48 hour period.
   e. The supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.
   f. It shall provide meters to indicate battery voltage and charging current.
   g. The main power supply shall be power-limited per 1995 UL864 requirements.

9. System Circuit Supervision:
   a. Each FACP node shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communications with these devices. The FACP CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information on the printer.
   b. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.
10. Field Wiring Terminal Blocks: For ease of service, all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Fixed terminal blocks are not acceptable.
11. Operators Terminal: Provide the following functions in addition to any other functions required for the system.
   a. Acknowledge (ACK/STEP) Switch:
      1) Activation of the control panel Acknowledge switch in response to a single new Alarm and/or trouble condition shall silence the local panel piezo electric signal and change the system alarm or trouble LED from flashing mode to steady-ON mode. If additional new alarm or trouble conditions exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
      2) Depressing the acknowledge switch shall also silence all remote annunciator piezo sounders.
   b. Signal Silence Switch: Activation of the signal silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm activation. The selection of notification circuits and relays which are silence able by this switch shall be fully field programmable within the confines of all applicable standards.
   c. System Reset Switch: Activation of the system reset switch shall cause all local electronically-latched initiating devices, software zones, output devices and circuits, to return to their normal condition.
   d. If an alarm condition(s) still exists, or if they reoccur in the system after system reset switch activation, the system shall then resound the alarm conditions.
   e. System Test Switch: Activation of the system test switch shall initiate an automatic test of all intelligent/addressable detectors in the local system. The system test shall activate the electronics in each intelligent sensor, simulating an alarm condition and causing the transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the system LCD and on any CRTs or printers in the system.
   f. Lamp Test Switch: Activation of the lamp test switch shall sequentially turn on all LED indicators, system liquid crystal display and local piezo signal, and then automatically return the fire alarm control panel to the previous condition.
12. Field Programming:
   a. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
   b. All local FACP node programming shall be accomplished through the FACP keyboard or through the video display terminal.
   c. All field defined programs shall be stored in non-volatile memory.

d. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual on/off commands. A second (higher-level) is used for actual change of program information.

13. Specific System Operations:
    a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.
    b. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
    c. System Point Operations:
        1) All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
        2) Any FACP node output point may be turned on or off from the local system keypad or the video terminal.
    d. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:
        1) Device Status
        2) Device Type
        3) Custom Device Label
        4) Software Zone Label
        5) Device Zone Assignments
        6) Detector Analog Value
        7) All Program Parameters
    e. System Status Reports: Upon command from a password-authorized operator of the system, a status report will be generated, and printed, listing all local FACP system status.
    f. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.

       The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
    g. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

       If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

H. Addressable Devices – General:
    1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches.

2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP signaling line circuit.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Class A applications.
8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. A magnetic test switch shall be provided to test each detector for 100% obscuration, reported to the FACP.
12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

I. Addressable Pull Box (manual station):
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key. Manual pull stations shall be of the double action type.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
4. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

J. Intelligent Photoelectric Smoke Detector:
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

K. Intelligent Thermal Detectors:
1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 99 intelligent heat detectors may connect to one SLC loop.

L. Intelligent Duct Smoke Detector:
1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

M. Addressable Dry Contact Monitor Module:
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

N. Two Wire Detector Monitor Module:
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box or with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

O. Addressable Control Module:
1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.

2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

P. Isolator Module:
1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

Q. LCD Alphanumeric Display Annunciator:
1. The alphanumeric display annunciator shall be a supervised, back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.
3. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as, system acknowledge, silence and reset.
4. LCD display annunciators shall mimic the local control panel 80 character display or network annunciator and shall not require special programming.

R. Batteries and External Charger:
1. Battery:
   a. Batteries shall be 12 volt, Gell-Cell type.
   b. The battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 15 minutes of alarm upon a normal AC power failure.
   c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

S. Speaker/Strobe Units:
1. One-way Tone/Voice Communication:
   a. The evacuation alarm and alert signals shall be capable of being initiated automatically from the fire alarm control panel (FACP) and transmitted to any speaker circuit, selected speaker circuits or all speaker circuits.

b. The alarm signal, alert signal and live voice announcements shall be capable of manual transmission from the FACP to any speaker circuit, selected speaker circuits or all speaker circuits by manual selection of the associated speaker circuit control switches.

c. Live voice announcements, via the hand-held microphone or patched in warden phone, by use of speaker control switches, shall take priority over all previously activated alarm inputs. In addition to NFPA 72 requirements, the system shall be capable of priority live voice announcements over subsequent alarm conditions. In no case shall subsequent alarms disrupt emergency live voice announcements.

d. Alarm speaker amplification equipment shall be sized, as a minimum, to provide the following wattage levels for each location type of alarm speaker:
   1) Each floor alarm speaker: Provide one (1) watt of input power.
   2) Each toilet alarm speaker: Provide one-half (1/2) watt of input power.
   3) Each mechanical room alarm speaker: Provide two (2) watts of input power.
   4) Each stairwell alarm speaker: Provide one-half (1/2) watt of input power.

e. Each elevator cab alarm speaker: Provide one-quarter (1/4) watt of input power.

f. As a minimum, alarm speaker amplification equipment shall be sized to provide the above indicated wattage of input power to each location type of alarm speaker shown on the Drawings, plus twenty-five percent (25%) spare capacity to permit the addition of future alarm speakers.

g. Alarm speaker amplifiers shall be paired to provide 100% redundancy. One (1) back-up alarm speaker amplifier shall be provided for each primary alarm speaker amplifier. If any primary alarm speaker amplifier fails, its function shall be taken over by its backup amplifier. Provide dedicated power amplifiers for each speaker circuit (4 min.) with one dedicated backup.

h. Alarm tone and alert tone oscillators and pre-amplifiers shall be paired to provide 100% redundancy.

i. As a minimum, each stairwell shall be provided with a dedicated notification appliance circuit.

j. As a minimum, the system shall be configured as a two (2) channel voice system.

k. Within the individual assembly occupancies in this project, an alarm received during a program occupancy shall sound an alert alarm at a constantly attended location and perform the following actions:
   1) Deliver a field programmable, digitized custom evacuation message to the occupants, detailing evacuation instructions.
   2) A simultaneous message shall be delivered via all alarm speakers installed in remainder of the building directing evacuation using exits other than the assembly occupancy exit path.
   3) Perform all control functions as detailed elsewhere in this specification
   4) An automatic announcement or tone evacuation signal shall be capable of interruption by the operation of the system microphone to give voice evacuation instructions overriding the pre-programmed sequences

l. Visual Unit (Xenon Strobe):
   1) Combination speaker strobe units - Provide Truealert Non-Addressable 75 Cd, Red Sync. 2-Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 75 Cd from all axis.
   2) Combination speaker strobe units - Provide Truealert Non-Addressable 110 Cd, Red Sync. 2-Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 110 Cd from all axis.
   3) Visual only – Provide Truealert Non-Addressable 15 Cd, Red Sync. 2-Wire comprised of a 24 VDC Xenon flash tube entirely solid state.

T. Provide a digital communicator with point ID, UL listed and in accordance with local Fire Department requirements and connect to telephone demarcation backboard with (2) CAT 6 telephone cables in 3/4”C for remote central station monitoring.

U. Exterior Strobe-unit:

Provide wall mounted, 24 VDL strobe, color red with WRR wall bracket.

V. Provide clear plastic covers with local audible alarm for pull stations in gym, locker rooms, etc. and as indicated on drawings or required by Fire Department.

W. Magnetic Door Holders:
1. Provide Semi-Flush Wall Mounted, or Floor Mounted, 24 V.D.C. with catch plate.

X. Key Repository Box:
1. Provide a key repository box(es) in accordance with fire department requirements.

Y. Field Quality Control
1. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
2. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
   a. Factory trained and certified.
   b. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
   c. International Municipal Signal Association (IMSA) fire alarm certified.
   d. Certified by a state or local authority.
   e. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
3. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
4. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
5. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
6. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
7. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
8. Final Test, Certificate of Completion, and Certificate of Occupancy:
   a. Test the entire system 100% devices as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.
9. Provide 8 hours of customer training.

2.17 SURGE PROTECTION

A. Scope

1. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all main service and panelboards.

B. Submittals

1. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
2. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking “Certifications” link, searching using UL Category Code: VZCA and VZCA2:

    a. Short Circuit Current Rating (SCCR)
    b. Voltage Protection Ratings (VPRs) for all modes
    c. Maximum Continuous Operating Voltage rating (MCOV)
    d. I-nominal rating (I-n)
    e. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
3. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
4. Minimum of ten (10) year warranty

C. Related Standards

1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
3. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
4. National Electrical Code: Article 285
5. UL 1283 - Electromagnetic Interference Filters
6. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

D. Quality Assurance

1. Manufacturer Qualifications: Engage a firm with at least 5 years experience in manufacturing transient voltage surge suppressors.
2. Manufacturer shall be ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

E. Delivery, Storage and Handling

1. Handle and store equipment in accordance with manufacturer’s Installation and Maintenance Manuals. One (1) copy of this document to be provided with the equipment at time of shipment.

F. Manufacturers

1. Provide an internally mounted Surge Protective Devices (SPD) formerly called Transient Voltage Suppressor (TVSS) by:
   a. Siemens Industry.
   b. Current Technology
   c. LEA
   d. Liebert
   e. APT
   f. Or equal

G. Electrical Distribution Equipment

1. Service Entrance
   a. SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
   b. SPD shall be factory installed integral to electrical distribution equipment.
   c. SPD shall be UL labeled with 20kA I-nominal (I-n)
   d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
   e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
   f. True 10 Mode Protection paths: SPD shall provide “directly connected protection elements” between all possible modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
   g. SPD shall be connected external of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
   h. SPD shall meet or exceed the following criteria:
      1) Maximum 7-Mode surge current capability shall be [300kA] [400kA] [500kA] per phase.
      2) Maximum 10-Mode surge current capability shall be [300kA] [450kA] per phase.
      3) UL 1449 - Third Edition Revision; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

   i. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

   j. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
   k. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.

l. SPD shall include a serviceable, replaceable module.
m. SPD shall be equipped with the following diagnostics:
   1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
   2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
   3) Form C dry contacts
   4) Optional – Surge Counter
   5) No other test equipment shall be required for SPD monitoring or testing before or after installation.
n. SPD shall have a response time no greater than 1/2 nanosecond.
o. SPD shall have a 10 year warranty.

2. Distribution Panel
   a. SPD shall be UL 1449 labeled as Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
   b. SPD shall be factory installed integral to electrical distribution equipment.
   c. SPD shall be UL labeled with 20kA I-nominal (I-n)
   d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
   e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
   f. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
   g. SPD shall meet or exceed the following criteria:
      1) Maximum 7-Mode surge current capability shall be 100kA per phase.
      2) Maximum 10-Mode surge current capability shall be 150kA per phase.
      3) UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

   h. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/277	15%	320V

   i. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
   j. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.
   k. SPD shall include a serviceable, replaceable module.
   l. SPD shall be equipped with the following diagnostics:
      1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
      2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
      3) Form C dry contacts

4) Optional – Surge Counter
No other test equipment shall be required for SPD monitoring or testing before or after installation.

m. SPD shall have a response time no greater than 1/2 nanosecond.
n. SPD shall have a 10 year warranty.]

3. Branch Panels
a. The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.
b. The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
c. SPD shall meet or exceed the following criteria:
1) Maximum 7-Mode surge current capability shall be 100kA per phase.
2) Maximum 10-Mode surge current capability shall be 150kA per phase.
3) UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

d. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (%)	MCOV
208Y/120	25%	150V
480Y/347	15%	320V

e. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of -50dB at 100 kHz.
f. Suppression components shall be heavy duty ‘large block’ MOVs, each exceeding 30mm diameter.
g. SPD shall include a serviceable, replaceable module.
h. SPD shall be equipped with the following diagnostics:
1) Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
2) Audible alarm with on/off silence function and diagnostic test function (excluding branch).
3) Form C dry contacts
4) Optional – Surge Counter
No other test equipment shall be required for SPD monitoring or testing before or after installation.
i. SPD shall have a response time no greater than 1/2 nanosecond.
j. SPD shall have a 10 year warranty.
k. The unit shall have removable interior.
l. The main bus shall be [copper] [aluminum] and rated for the load current required.
m. The unit shall include a 200% rated neutral assembly with copper neutral bus.
n. The unit shall be provided with a safety ground bus.
o. The field connections to the panelboard shall be main lug or main breaker.
p. The unit shall be constructed with flush or surface mounted trim and shall be in a NEMA Type 1 enclosure.

H. Installation
1. Install per manufacturer’s recommendations and contract documents.

I. Adjustments and Cleaning
1. Remove debris from installation site and wipe dust and dirt from all components.
2. Repaint marred and scratched surfaces with touch up paint to match original finish.

J. Testing
1. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.
2. Check all installed panels for proper grounding, fastening and alignment.

K. WARRANTY
1. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

2.18 AUTOMATED LIGHTING CONTROL SYSTEM

A. Introduction
1. The work covered in this section is for a SQD Powerlink G3-3000 (or equal by GE, Eaton, Siemens or others) level lighting control system or approved equal, web based and is subject to all the requirements in the General Conditions of the Specifications.
2. The contractor shall coordinate all of the work in this section with all of the trades covered in other sections of the specification to provide a complete and operable system.

B. Description of Work
1. The extent of the lighting control system work is indicated by the drawings and by the requirements of this section. It is defined to include, but not by way of limitation:
   a. Panelboards containing remotely operable circuit breakers
   b. Control electronics for switching circuit breakers and monitoring the status of the system
   c. Associated low voltage switches, occupancy sensors and external time clocks
   d. Any work stations, software and communications hardware
2. System installation includes the following:
   a. Wiring of main and branch circuit conductors
   b. Installation of external control devices and wiring to the panelboard controller
   c. Installation of communications conductors and associated hardware

C. Quality Assurance
1. Manufacturers: Firms engaged in the manufacture of lighting control equipment and ancillary equipment, of the types indicated, whose products have been in satisfactory use in similar service for not less than five years.
2. Component Testing: All electronic component board assemblies are to be factory tested and burned in prior to installation.
3. System Support: Factory fax/telephone/email support shall be available free of charge during normal business hours.
4. NEMA Compliance: Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.
5. NEC Compliance: Comply with applicable portions of the NEC including Articles 110-10 and 725.
6. UL Compliance: Comply with applicable UL standards for panelboards, circuit breakers and energy management equipment.
7. FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15, Subpart J for Class A applications.
8. IEC 1000: Electronic components shall meet or exceed levels specified below:

a.	ESD Immunity	IEC 1000, Level 4
b.	RF Susceptibility	IEC 1000, Level 3
c.	Electrical Fast Transient Susceptibility	IEC 1000, Level 3
d.	Electrical Surge Susceptibility—power line	IEC 1000, Level 4
e.	Electrical Surge Susceptibility—interconnection lines	IEC 1000, Level 3

9. ISO 9002: Manufacture of hardware and software components shall be registered as ISO 9000 compliant.

D. Warranty
1. Manufacturer shall warrant specified equipment to be free from defects in materials and workmanship for at least one year from the date of acceptance.

E. Submittals
1. Product Data Sheets: Submit manufacturer's data sheet for the lighting control system and specified components
2. Panel Drawings: Submit manufacturer's dimensional drawings and circuit breaker placement locations for each panelboard.
3. One Line Diagram: Submit a one-line diagram of the system configuration proposed if it differs from that illustrated in the riser diagram included in these specifications.
4. Typical Wiring Diagrams: Submit typical connection diagrams for all components including, but not limited to, panelboards, low voltage switches, occupancy sensors, light level controllers, communications devices, and personal computers.

F. Automated Lighting Control System
1. The ALCS shall consist of microprocessor-based control electronics with remotely operated circuit breakers mounted to a UL67 listed lighting panelboard interior and enclosed in a UL50 listed panelboard enclosure. The circuit breakers shall provide overcurrent protection, and have an AIR rating or series connected rating that meets or exceeds the fault current of the system to which the panelboard is being applied.
2. Each master control panel shall meet or exceed the following capabilities:
   a. Sixteen (16) 2-wire input terminals for connection to external low voltage switch contacts.
   b. Capable of remotely controlling 168 branch circuits in a master/slave configuration.
   c. Provide true status feedback by monitoring branch circuit breaker status based on actual system voltage at load side terminal.
   d. Accept remote commands via network connection.
3. All lighting control components shall be installed in a conventional panelboard 20 inches wide or column-width enclosures (as noted on drawings). Suitable barriers shall be installed to separate Class 2 wiring from power conductors.

G. Hardware
1. To minimize space requirements, the remotely operated circuit breakers and electronics shall be integral to the lighting panelboard.
2. Remotely Operated Circuit Breakers—all remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for the location in the electrical system, as defined in the panelboard schedules. Remotely operated power switching devices shall have the following:
   a. Integral branch circuit overcurrent protection as required by the National Electrical Code (NEC). All circuit breakers shall have a UL Listed interrupting rating sufficient for the application or shall have UL Listed series connected ratings for the maximum available fault current at that point in the system. Submittals reflecting the use of relays or contactors to perform remote switching must show evidence in writing that the relay can safely withstand the available fault current.
   b. UL Listed SWD ratings for 15A and 20A 1-, 2- and 3-pole branch devices, HID ratings, and HACR ratings.
   c. Handle operator that shall mechanically open the power switching device contacts when moved to the OFF position and disable the contacts from being remotely closed.
   d. Manual override switch to enable or disable the remote operation of the device.

e. Visible flag that clearly indicates the status of the circuit breaker contacts with the panel trim installed. Flag shall indicate: ON, OFF, and TRIPPED circuit breaker states. The visible flag shall be mechanical in nature, directly tied to the circuit breaker mechanism, and shall be provided in addition to any status indicator supplied by the system electronics.

f. Switching endurance rating of 200,000 open/close remote operations. Switching devices with lower ratings may be judged to be acceptable, but must be provided with [100%] [200%] spare switching devices for each circuit to ensure an equivalent total number of operations.

g. Panel controllers shall incorporate a web-enabled server for displaying information over a standard web browser. Web-accessible information shall include:
   1) A secure, password protected login screen for modifying operational parameters to ensure only authorized access. Password administration shall be accessible to authorized users via web page interface.
   2) Separate web pages for each panel with the arrangement of breakers on the page matching the physical appearance of the panel. Panel status pages shall also include breaker nametags, pole configuration, location in panel, and actual contact state (On/Off/Tripped/Manual) for the master panel and each associated slave panel. The web page shall also provide the ability to observe breaker On-time and blink information in real time.
   3) Panel summary showing the master and all slave panels connected to the controller.
   4) Controller summary showing controller diagnostic information.
   5) For a consistent user interface provide remote front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. Mimic screens shall also allow direct breaker control and zone overrides.
   6) The user interface shall share a common “look and feel” between panels and other web-enabled distribution equipment.

h. Each master controller shall incorporate an alarm and automated e-mail notification service. These services shall be capable of automatically initiating alarms based on preconfigured conditions and routing alarm alerts as directed by the customer. Customer shall furnish a list of alarms to be configured and email addresses to receive each alarm.
   1) Alarms shall be configurable for the following parameters:
   2) Global alarms: power loss, non-responding breakers, loss and restoration of sub-net communications, loss and restoration of serial port communications, loss and restoration of Modbus TCP Ethernet commands.
   3) Specific alarms: input status, zone status, breaker status on-time (0 to 99999 hours) and strike counter.
   4) Email notification service shall include the ability to automatically route an email message to five individual email addresses. Within the body text of the email, provide a link that will automatically redirect the user to the associated panels’ status web page.

i. Each panel controller shall incorporate a time synchronization service to update controller clock to a network time server. Time serve shall incorporate both a primary and secondary source. Update interval shall setable from 1 to 24 hours.

3. Lighting Control Electronics—Master Panelboards
   a. Panels used as master panels shall contain both a power supply module and controller in the indicated spaces. Master panels provide power and control for operating and monitoring remotely operated branch circuit breakers connected to control busses located in master and slave panelboards. One power supply module and controller shall support up to eight (8) control busses. Master panels shall contain a nameplate label, located on the panel trim indicating its designation, automation level network address, and the designations and addresses of all associated slave panels connected to its sub-net.
   b. A power supply module shall be furnished to provide control power for the operation of the remotely operated circuit breakers, controller, bus system and low voltage inputs. Power module(s) shall connect directly to the panel interior and receive line voltage from the panel bus. Power module(s) shall be internally self-protected and operate within a range of –15% to +10% of its nominal line voltage rating.
   c. The controller shall operate whenever voltage is within the power supply operating range. In the event of incoming power outage, the controller shall automatically halt execution in a safe manner. Upon return of power, the controller shall automatically reboot and return to normal system operation. The controller shall include the following:
      1) Integral keypad and LCD front panel for local setup. Front panel setup shall permit local input setup and creation of time schedules without requiring separate PC-based software.
      2) RS232 serial communications interface to permit local connection to personal computer without having to remove panel trim.
      3) Non-volatile memory to retain all setup and configurations.
      4) Eight (8) three-wire input terminals configurable for either eight (8) three-wire momentary operation, or sixteen (16) two-wire, or (8) two-wire operation with status feedback. All configurations shall allow either momentary or maintained control devices to be attached without providing any external control power.
      5) An auxiliary power source for powering external control devices such as occupancy sensors, low voltage photo sensors, and pilot LEDs, as indicated on drawings.
      6) Programmable input timers to permit timed override periods.
      7) Adjustable blink notice assignable to any remotely operated circuit breaker(s) connected to the system.
      8) Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
   d. Time scheduler shall provide, at minimum, the following:
      1) Sixteen (16) independent schedules, each having twenty-four (24) time periods.
      2) Clock configurable for 12-hour (AM/PM) or 24-hour format.
      3) Schedule periods settable to the minute.
      4) 365-day calendar, with automatic daylight savings and leap year adjustments.
      5) Day-of-week, day-of-month, day-of-year with one-time or repeating capability.
      6) Thirty-two (32) special date periods.
      7) Astronomical tracker to automatically adjust sunrise and sunset times throughout the year.
   e. Each master controller shall have the capability of communicating to another master controller in a peer-to-peer configuration.
      1) Each input connected to the controller shall be capable of controlling any branch circuit connected to any other controller.

2) A schedule programmed in one controller shall be capable of controlling any branch circuit connected to any other controller.

f. Master controllers shall have the capability of configuring either local or remote sources in an “AND”, “OR”, or “LAST EVENT” configuration. Sources shall include, but not be limited to, inputs, time schedules, or status. Up to four sources shall be permitted in a custom configurable logic arrangement.

4. Lighting Control Electronics—Slave panels (slave panels shall be allowed only when housed in same room as master panels)
   a. Panels marked as slave panels shall contain the necessary busses and network hardware to allow connection of the sub-net wiring between panels.
   b. Sub-net wiring connections shall allow connection of wiring to a terminal that can be removed from the panel without interrupting the communications to other panels.
   c. Slave panels shall contain a nameplate label attached to the deadfront trim indicating the panel designation, network address of the panel, and the panel designation of the associated master panel.

H. Networks
1. Future integration and service shall be promoted by using only open communication protocols between lighting control panels. An open protocol is one that has specifications published in the public domain and that is used by more than 10 manufacturers. Modbus, Modbus (TCP/IP), DMX, BACnet are considered acceptable. Submittals listing any other protocol will not be considered unless they demonstrate that these criteria are met. The same open protocol shall be used over all media that are part of the system, including serial busses, the LAN, or other connections.
2. Installation of additional special purpose networks shall be minimized by using the existing facility Ethernet LAN to connect various lighting panels or groups of lighting panels as shown on the drawings. Equipment shall be compatible with industry standard TCP/IP protocols.
3. Power Monitoring metering devices as shown on the drawings shall connect using the same network as the lighting control panels. The controller shall support a pass-through mode for Modbus connected meters whereby the information is automatically ported to the Modbus TCP/IP port without separate gateway devices.
4. Provide sub-net wiring between master and slave panels as indicated on the drawings. Sub-net wiring shall permit slave panels to receive power and control data from the master panelboard. No more than eight (8) bus rails shall be connected to the sub-net.
5. Sub-net communications shall follow Class 1 wiring practices. Communications conductors shall be Belden 27326 or equal having the same voltage rating as the branch circuit conductors. Wiring distances shall not exceed the manufacturer’s recommendations.
6. Communications wiring to master panels shall use Category 5 cabling. Installing contractor shall coordinate work with the network administrator to assure that proper connection points are available. The installing contractor shall also secure one static IP address for each master controller.

I. Configuration Software
1. Configuration software shall be designed specifically for the lighting control system and supported by the manufacturer. Software shall support system configuration and monitoring and control functions in a Windows environment.
2. For basic setup and control, the software shall serve as a configuration and diagnostic utility. Basic features shall include support for configuring inputs, zones, circuit breaker actions, and time schedules. Software shall be able to monitor the status of the system and provide visual indication of input status, circuit breaker status, and operational parameters. Software shall be able to establish connections to the system through a

controller front port, RS232 port, RS485 port, and Ethernet port. Support for remote system dial-up shall be incorporated into the software package.

3. Coordinate with Owner for Owner furnished suitable PC to host software. Install software as required. Lighting control system shall be web-based. Provide required wiring and outlets to connect to Owner's network.

J. The Automated Lighting Control System (ALCS) BACnet Interface shall share the following information the BACnet enabled Building Automation System and other building systems as required:

PROPERTY	BACnet TYPE	DESCRIPTION
Light Zone State	Binary Value*	State of the defined lighting zone - ON or OFF
Light Zone Dimming	Analog Value*	Light output level of the defined lighting zone, from 100% (maximum light output) to 0% (minimum light output)
Fire Alarm State	Binary Input	State of the fire alarm system: alarm activated or alarm not activated
Occupancy State	Binary Output	State of the defined occupancy sensor – occupancy detected or not detected
Sheddable Load	Analog Output	Reports the total lighting load available for load reduction according to ALS, defined in Watts
Shed Status	Analog Output	Reports the total current load reduction achieved according to ALS defined prioritization, defined in Watts
Shed Request	Analog Input	Requested total amount of load reduction, defined in Watts or as a percentage of sheddable load
Sheddable Load (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Status (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Request (Group)	Analog Input	(As above, unprioritized for the selected group)

1. Occupied Mode Functionality: The ALCS shall not isolate occupants by turning off lights that are still required for convenience and safety, such as a hallway path to exit the premises.
   a. Time Clock Scheduling: The ALCS shall be programmable for scheduling lights on or off.
      1) Override: Manual adjustments and occupancy sensor detection shall temporarily override off status imposed by time clock schedule.

2) Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage. All life safety lighting shall be brought to maximum light output until utility power is restored.
3) Flick warning: Ten minutes prior to a scheduled lights-off event or expiry of a temporary override, the System shall provide two short light level drops as a warning to the affected occupants.

b. Load Shed: An automatic load shedding function shall be available where, when activated through the ALCS, the control unit will reduce its output to a programmable maximum electrical demand load. The ALCS shall not shed more load than required and load shedding priority shall be centrally configurable by zone. The individual user shall retain the ability to override ALCS light levels below the load shedding levels only. Load shedding levels shall be as indicated on the lighting plans or as required by the owner during system setup and commissioning.

c. Emergency: There shall be a function, when activated through the ALCS, that will immediately adjust lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs. This mode shall be activated whenever the building fire alarm detection system is in alarm or normal utility power has been lost.

2. Unoccupied Mode Functionality: The ALCS shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable light level.

a. Time Clock Scheduling: The ALCS shall be programmable for scheduling lights on or off.
1) Override: Manual adjustments and occupancy sensor detection shall temporarily override off status imposed by time clock schedule.
2) Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
3) Flick warning: Ten minutes prior to a scheduled lights-off event or expiry of a temporary override, the System shall provide two short light level drops as a warning to the affected occupants.

b. Emergency: There shall be a function, when activated through the ALCS, that will immediately adjust lights to full light output and retain that level until the mode is deactivated. This setting shall override all other inputs. This mode shall be activated whenever the building fire alarm detection system is in alarm.

K. Provide 8 hours of Owner training after programming is complete. Provide 8 hours of owner training at end of job.

2.19 LADDER TRAY/WIREWAYS

A. Provide 12" wide aluminum ladder tray with 6" rung spacing with 4" side rail. Ladder tray shall be as manufactured by B-Line. “Ladder Type”. Provide all hangers required.

B. Wireway:
1. This specification covers NEMA type 1 wireway used to house ad protect communication cable. The wireway system shall consist of wireway and appropriate fittings to complete the installation per the electrical drawings.

2. Metal wireway (NEMA type 1) is to be utilized in dry interior locations only as covered in article 362 part a of the national electrical code, as adopted by the national fire protection association and as approved by the American National Standards Institute. The wiremold c" or "sp" series is listed by underwriters' laboratories under file no. E137690 guide zoyx.
3. The wireway system specified herein shall be the "c" or "sp" system as manufactured by the wiremold company. Systems of other manufacturers may be considered equal if, in the opinion, and the written approval of the engineer, they meet all the performance standards specified herein.
4. The wireway and all system components must be UL Listed in full compliance with their standard ul870, "electrical wireways, auxiliary gutters and associated fittings". It shall be manufactured from 16-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. All sizes larger than 6" x 6" shall be manufactured from 14-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. A factory installed divider shall be available to separate power and low voltage wring housed n the same wireway sections.
5. A full compliment of fittings for the raceway shall be available including, but not limited to, 45 degrees and 90 degrees flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of wireway, reducers, hangers, end blanks, a field installed divider and all other components necessary to make the system workable. The fittings shall have an ASA 61 gray powder coat paint finish to match the wireway.
6. Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.
7. All wireway systems shall be mechanically continuous and connected to all electrical boxes and cabinets, in accordance with manufacturer's installation sheets.
8. All connections shall be checked to make sure they are correctly tightened and to insure that all wireway shall be electrically continuous and bonded in accordance with the national electric code for proper grounding.
9. All wireway systems shall be installed complete. Work shall include fastening all wireway and appropriate fittings to install a complete wireway system as indicated on the electrical and/or communication drawings and in the applicable specifications

2.20 DUAL TECHNOLOGY CEILING OCCUPANCY SENSORS:

A. Occupancy sensors shall be capable of detecting occupants within the coverage area designated via detection of a doppler shift in the transmitted ultrasonic sound wave and a change in the infrared heat present. Major motion and minor motion shall cause the controlled load to switch to the "ON" mode.

B. Occupancy sensors shall provide multiple options for initial sensing and confirmation of an occupant so as to conform to environmental factors. Initial detection may be made by either technology or may require both technologies to switch the load to "ON".

C. Ultrasonic sensor component shall operate at 32.7 kHz and shall be controlled by a quartz crystal oscillator within 0.005 percent. Ultrasonic sensors shall not cause interference with other sensors when mounted within the same area of coverage.

D. Ultrasonic sensor component shall have dedicated transducers for transmission and reception which are temperature and humidity resistant. Ultrasonic receivers shall be temperature and humidity resistant with less than a 6 dB shift in the humidity range of 10 percent – 90 percent and less than a 10 dB shift in the temperature range of –20 to 60 C.

E. Passive infrared sensor component shall use a multi-level 100 segment Fresnel lens and four pyroelectric detectors to insure adequate PIR coverage of the intended area.

F. Occupancy sensors shall have on override to “ON” bypass logic key in the event of sensor failure.

G. Occupancy sensors are to be ceiling mounted using a back mounting plate and standard electrical outlet boxes.

H. Occupancy sensors shall have 4 LED’s to indicate proper operation and to confirm walk test detection. Ultrasonic detection shall be represented by a set of green LED’s. Passive infrared detection shall be represented by a set of red LED’s.

I. Occupancy sensors shall have an additional single pole double throw isolated relay with normally open, normally closed and common output rated at 1A@24VDC/120VAC.

J. Occupancy sensors shall be designed to eliminate nuisance tripping from RFI and EMI.

K. Occupancy sensors may be wired in parallel with up to 2 sensors per powerpack.

L. Provide power pack to derive operating voltage for sensor and to switch 20 amperes of ballast-type lighting load; power pack shall be suitable for use in air-handling plenums.

M. Occupancy sensors shall cover up to 2000 sq. ft. for walking motion, with a field of view of 360 degrees for classrooms and large spaces and cover up to 900 square feet for offices, toilets, conference rooms, etc.

N. Occupancy sensors shall have a user adjustable sensitivity.

O. Occupancy sensors shall operate on 24 VDC; supplied by #211-1, #212-1 or #213-1 power packs, current draw @ 33mA (EMS version current draw is 50 mA).

P. Occupancy sensors shall be compatible with electronic ballasts, compact fluorescent, and inductive loads.

Q. Occupancy sensors shall have a standard 5 year warranty and shall be UL listed.

R. Acceptable Manufacturers:
1. Hubbell
2. Wattstopper
3. Sensor Switch
4. Or equal

S. Identify wiring devices with circuit number as required in Section 26 0553, Identification for Electrical Systems.

T. Inspect each wiring device for defects before installing.

U. Adjust time-out controls each occupancy sensing light switches to the following settings:

1. Classrooms, private offices, open offices, laboratories, and restrooms: longest time out setting, but not more than 30 minutes.
2. Break rooms, storage rooms, and copy machine rooms: 5-minute time-out setting.
3. Conference rooms: 10-minute time-out setting.

4. Corridors and lobbies: 15-minute time-out setting.

V. Adjust ambient light sensor in occupancy sensors to hold off or reduce the electric lighting when daylighting exceeds 80% of the design illuminance at the work area. (For example, in an office with a design illuminance of 50 footcandles, the ambient light sensor should keep the lights off as long as the daylighting exceeds 40 footcandles.

2.21 SEALS

A. Water Tight Seals
1. Conduits entering from the exterior or below grade shall have water tight fittings on the outside and on the inside of the conduit.
   a. Fittings on the outside of the conduit shall be O-Z Gedney type FSK or equal. Provide type WSK if penetration is within two feet of the high water table. Provide grounding attachment.
   b. Fittings on the inside of the conduit shall be O-Z Gedney type CSBI or equal. Provide type CSBG if penetration is within two feet of the high water table. Provide a blank fitting to seal spare or empty conduits.
   c. O-Z Gedney type CSM fitting may be used when sealing within a sleeve or cored hole.
2. Submit on seals to be used.

B. Environmental Seals
1. Provide seals on raceways exposed to widely different temperatures, as in refrigerating or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.

C. Hazardous Area Seals
1. Provide explosion proof seals as required by the Electric Code for the following areas.
2. Explosion proof exhaust fans.

D. Smoke and Fire Stopping Seals
1. Provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air handling ducts so that the spread of fire or products of combustion shall not be substantially increased.
2. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings shall be firestopped using approved methods and NRTL listed products to maintain the fire resistance rating.
3. Fire stopping in sleeves or in areas that may require the addition or modification of installed cables or raceways shall be a soft, pliable, non-hardening fire stop putty. Putty shall be water resistant and intumescent. Provide for all sleeves and raceways.
4. Firestopping in locations not likely to require frequent modification shall be NRTL listed putty, caulk or mortar to meet the required fire resistant rating.
5. Box penetrations into a fire rated wall or shaft shall have a fire stopping pad installed on the back of the box.
6. Firestopping of cable trays or busways through walls shall be within a non-hardening putty or with seal bags.
7. Firestopping materials shall be NRTL listed to UL 1479 (ASTM E814). Installation methods shall conform to a UL firestopping system. Submit specifications and installation drawings for the type of material to be used. Firestopping materials shall be as manufactured by 3M, International Protective Coatings Corp., RayChem or equal.

2.22 UNDERGROUND DUCTBANKS

A. General: Furnish and install the ductbanks as herein specified and as shown on drawings.

B. Division of Work:
1. The General Conditions shall be responsible for the work and material required for the following:
   a. Excavation
   b. Backfill
   c. Installation of handholes/manholes
   d. Brick or concrete collars to bring handhole frames and covers up to grade. Installation of frames and collars which are to be furnished by the Electrical Contractor.
   e. Concrete Encasement
2. All other material, equipment, and labor required for the complete ductbank shall be furnished and installed by the Electrical Contractor under this Section, including the following:
   a. Service raceways.
   b. Grounding material.
   c. Ductbank warning tape.
   d. Furnishing pre-cast handholes/manholes.
   e. Conduit spacers.

C. Materials:
1. Conduit: UL listed, schedule 40 PVC in accordance with NEMA standard TC-2.
2. See BASIC MATERIALS SECTION.
3. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3".
4. Tags: Non-ferrous metal or fibre, 1/4" high letters.
5. Warning tape shall be yellow polyethylene 4 mil thick, 6" wide terratape, similar to REEF Industries, Houston, Texas and shall be installed above all ductbanks both high and low tension.

D. Duct System:
1. The duct system shall consist of Schedule 40 PVC conduit except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.
2. The entire length between handholes and end of ductbank shall be excavated and graded before any conduit is laid.
3. The ductbank shall be set on sand bed.
4. The conduit shall be installed so that top is a minimum of 36" below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4" for each 100 feet of length. Duct system shall drain to manholes/handholes.
5. Changes in direction shall be made by long sweep bends, minimum radius 25 feet except that at the end of a run, within 10 feet of termination. Manufactured ends may be used having a minimum radius of 36 inches.
6. Conduit base and intermediate spacers shall be installed a maximum of 5 feet on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6".
7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered, minimum space between joints in adjacent conduit shall be 6 inches.
8. When the required number of conduits has been installed, securely tie the assembly together at distances not exceeding 7 feet. Tie shall consist of three (3) turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.

9. Duct envelope shall be vibrated to eliminate voids.
10. Ductbanks shall not be covered until the conduit installation has been observed by the utility company and Architect.
11. Warning tape shall be installed during backfilling and shall be placed approximately 12" above the conduits.
12. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be pulled through each conduit. The mandrel shall not be less than 12" long and the diameter approximately ¼" less than the conduit.

2.23 VARIABLE FREQUENCY DRIVES

A. The variable frequency drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable). The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

B. Specifications at 480 volts:
   1. Input VAC +/-10% (capable of operation to 550 VAC), 3 phase, 48-63Hz. Output 0 - Input Voltage, 3 phase, 0 to 500 Hz for drives up to 75 HP; 0 to 120 Hz for drives over 75 HP. Operation above 60 Hz. shall require programming changes to prevent inadvertent high speed operation. Environmental operating conditions: 0 to 40 C @ 3 kllz switching frequency, 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. Units shall be UL, CUL and CA approved.

C. All VFD's shall have the following standard features:
   1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control, for stepping through the displays and menus.
   2. The VFD shall give the user the option of either (1) displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last reference revised, or (4) cause a Warning to be issued, if the input reference (4-20mA or 2-10V) is lost; as selected by the user. The VFD shall provide a programmable relay output for customer use to indicate the loss of reference condition.
   3. The VFD's shall utilize plain English digital display (code numbers and letters are not acceptable). The digital display shall be a 40-character (2 line X 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
   4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
   5. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.

6. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
7. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and not inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
8. The customer terminal strip shall be isolated from the line ground.
9. Prewired 3-position Hand-Off-Auto switch and speed potentiometer. When in "Hand", the VFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
10. The drive shall employ three current limit circuits to provide trip free operation:
11. The Slow Current Regulation limit circuit shall be adjustable to 125% (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load. The Rapid Current Regulation limit shall be adjustable to 170% (minimum) of the VFD's variable torque current rating. The Current Switch-off limit shall be fixed at 255% (minimum, instantaneous) of the VFD's variable torque current rating. The overload rating of the drive shall be 110% of its variable torque current rating for 1 minute every 10 minutes, and 140% of its variable torque current rating for 2 seconds every 15 seconds, input line fuses standard in the drive enclosure. VFD shall have a DC Line Reactor to reduce the harmonics to the power line and to increase the fundamental power factor.
12. The VFD shall be optimized for a 4 kHz carrier frequency to reduce motor noise and provide high system efficiency. The carrier frequency shall be adjustable by the start-up engineer in ACH 501 units. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.

D. All VFD's to have the following adjustments:
1. Five (5) programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20 MA and 0-10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
4. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock), drive is to resume normal operation.

E. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):

Output Frequency
Motor Speed (RPM, % or Engineering units)
Motor Current
Calculated Motor Torque
Calculated Motor Power
DC Bus Voltage

Output Voltage
Heatsink Temperature
Analog Input Values
Keypad Reference Values
Elapsed Time Meter
kWh meter

F. Speed Command Input shall be via:
1. Keypad.
2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated form ground, and programmable via the keypad for different uses.
3. Floating point input shall accept a three-wire input from a Dwyer photohelic (or equivalent type) instrument.

G. Accessories to be furnished and mounted by the drive manufacturer.
1. Customer Interlock Terminal Strip-provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in hand, Auto or Bypass.
2. All wires to be individually numbered at both ends for ease of troubleshooting.
3. Door interlocked thermal magnetic circuit breaker which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.
4. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and in the "Bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes.
5. Pilot or LED's lights shall be provided for indication of "Normal" operation, "Bypass" operation, and "External Fault". All pilot lights shall be push-to-test type.
6. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor). The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.
7. A class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.

H. Compliance to IEEE - 519
1. The VFD manufacturer shall provide calculations specified to this installation showing that the Total harmonic Distortion for the VFD's, reflected into the electrical distribution system is limited to the level defined by IEEE - 519 (latest edition) for general systems. Harmonic analysis shall be included with VFD submittal for approval by the engineer.
2. The VFD manufacturer shall conduct on site harmonic measurements before and after start up of the VFD's. Results of the measurements, showing harmonic contribution of the VFD's, shall be provided to the engineer one month after start up.
3. Three phase A. C. input line reactors shall be provided as a minimum, with all VFD's. The line reactors are to provide attenuation of line side voltage transients, thus preventing overload trips or other unnecessary V.F.D. shutdown, and provide a reduction in harmonic distortion.

4. Line reactors shall meet the following requirement:
   a. Minimum of 3% line impedance (external to drive).
   b. 150% continuous current rating for one minute.
   c. Saturation rating no less than 2.5 times the continuous current rating.
   d. U.L. recognized.

I. General: Install variable frequency drives where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that variable frequency drives comply with requirements and serve intended purposes.

J. Access: Provide access space around control panels for service as indicated, but in no case less than that recommended by manufacturer.

K. Support: Install drive control panels on walls where indicated on drawings. Provide necessary Unistrut and structural steel to provide adequate support as required by manufacturer.

L. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

M. Start-Up
1. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.

N. Adjusting and Cleaning:
1. Alignment: Check compatibility of control panel to motor and where necessary, adjust frequency and provide necessary filters to assure noise free operation of motors. Verify response from control panel to motor to assure turn down ratio specified and that static pressure signals are being received and that drives are controlling as specified and within recommended tolerances by manufacturer. Provide start-up report prepared by manufacturer’s representative to assure operation is as specified.
2. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
3. Acceptable Manufacturers:

   Allen – Bradley
   ABB
   Siemens
   Square D

2.24 LIGHTNING PREVENTOR SYSTEM

A. Provide all labor, material, equipment, and services to perform all operations required for the complete installation and related work as specified herein and indicated on drawings for the early Streamer Emission System.

Any such work included in any other section of these specifications that is not specifically described therein shall comply with the requirements of this section.

The following items of work are specifically included in, but not necessarily limited to, the work of this section without limiting the generality implied by these specifications:

1. ESE lightning protection air terminal
2. Mast, complete with base and supports
3. Down conductors
4. Grounds
5. Surge Protective Devices

B. Submittals

1. Provide shop drawings showing location of ESE air terminal, mast conductors, installation procedures and details. Detailed manufacturer's data sheets on all components, accessories and miscellaneous equipment to be used in the installation shall also be submitted.
2. One complete set of independent performance testing documents on the ESE air terminal system shall be submitted to show compliance with the protection area of the unit submitted for the installation.

C. Description of System

1. The ESE installer shall provide a complete installation of equipment to comprise a complete system against damage by lightning. The ESE installer shall be responsible for all material and labor to accomplish this result.
2. The system, including the ESE air terminal, conductors, mast and complementary parts, shall be installed so that completed work is unobtrusive and does not detract from the building appearance.

D. Codes, Regulations, Permits

1. The completed system shall comply with the ESE manufacturer’s standard, equipment supplier drawings and specification requirements for installation of ESE lightning protection systems.

E. Standards of Quality

1. The ESE system equipment supplier, contractor, and installer shall install the ESE system in compliance with the ESE Manufacturer’s Standard.
2. The ESE system and manufacturer’s guarantees and warranties shall be submitted to the owner upon completion of the ESE system installation.

F. Service and Testing

1. Installation of equipment shall be done under the direct supervision of a manufacturer and per the manufacturer’s requirements.
2. The lightning protection installing contractor shall provide photos and/or video of the installation, including but not limited to, mast mounting, bonding connections (waterline & structural steel), down conductors, ground rods/grids and all buried, concealed or inaccessible connections and components. This information shall be forwarded to the ESE manufacturer for evaluation, certification, archiving and documentation.
3. The ground resistance of the completed system shall be measured using IEEE "Fall of Potential Method" in the presence of the Architect/Engineer and shall be forwarded to the ESE manufacturer. Ground resistance shall be ten (10) Ohms or less.

G. ESE Air Terminal

1. The complete assembly shall consist of: 5/8” air terminal which is HD 29 CU and heavy chrome plated 24 CH; lock nut and washer of chrome plated copper; support structure of chrome plated soft copper; and sphere shall be threaded to air terminal. The base of the ESE air terminal shall be threaded for interconnection to top of mast.

H. Conductors
1. Copper conductors shall be 28 strands of 14-gauge wire rope lay, with a net weight of 375 pounds per 1,000 feet (60mm2), minimum.
2. The structural steel may be utilized as main conductor if the steel is electrically continuous or is made so via other means. Every other column or an average of 60'-0" (18m) intervals shall be bonded and connected to the ground system.
3. All conductors shall be secured every 3'-0" (900mm) maximum. Fasteners and clips utilized shall be of equal corrosion resistance as the material being secured.
4. Bonding of all conductive material within 6'-0" (1800mm) of the conductor shall be accomplished via secondary conductor no smaller than #6 (14mm2) copper.
5. Bare copper material shall not be installed on dissimilar metals.
6. Corrosion resistant copper or bronze equipment shall be utilized where these conditions exist. Corrosion resistant copper conductors and fittings shall be utilized where corrosive atmospheres are present.
7. Conductors shall be installed so that a conductor shall always have a horizontal or downward path, free of "U" and "V" pockets, with the exception that an 8" (203mm) maximum rise or a rise of 3" (80mm) maximum for every 12" (300mm) of conductor length shall be permitted in a main conductor run.
8. Each ESE terminal shall have two (2) paths to ground from the base plate of the mast, with the exception of an elevated mast that may have a single conductor run for a maximum of 16'-0" (4880mm) before two (2) down conductors shall be initiated.
9. The electrical contractor shall furnish and install all necessary PVC conduit for concealed down conductors.
10. No bend of a conductor shall be less than ninety (90) degrees and shall not have a radius of bend of less than 8" (203mm). Exceptions are through roof and wall assemblies and "T" connections.

I. Mast
1. Aluminum or galvanized steel mast, height to be determined by the area of protection, with threaded connection for the ESE air terminal and bonding plate for cable connection. Wind and safety factors shall be documented for the geographic area of installation, to determine the size and structure of mast.
2. Base support, depending upon application, flat mounting base, side mounting base and/or structural support, and/or flag- pole may be utilized.

J. Grounding System
1. Ground rods shall be copperclad 3/4" (20mm) x 10' (3000mm), minimum. One set of tripod grounds shall be installed for each down conductor [two (2) minimum per system; refer to paragraph C, for structural steel used as down conductors, grounding requirements]. Ground plates of high conductivity copper sheet, 20 gauge minimum, 18 in. sq. 460mmsq. [three (3) required per down conductor], may be used in lieu of or in combination with ground rods to achieve the ten (10) ohm resistance grounding system requirement. The cable attachments to the ground rods must be accomplished via exothermic welds or mechanical clamp. Cable attachments to the ground plates shall be via cast bronze bond plates of eight 8in2 (5161mm2) of contact area.
2. A ground loop may be substituted for the ground rods or ground plates. The ground loop must be of a main size conductor and shall comply with the ten (10) Ohm resistance requirement of the grounding system.
3. Ground rods, ground plates, and ground loop conductors shall be installed a minimum of 1ft. (300mm) below grade and a minimum of 2ft. (600mm) away from the foundation. All grounding locations shall be as evenly spaced around the building perimeter as possible.
4. A minimum of one (1) inspection well, rated for the traffic of the installation area, shall be installed for each down conductor or two (2) minimum per ground loop.

5. Bonding of grounded systems shall be via main size conductors. The bonding shall be accomplished to achieve equal potential of all grounds. All underground connections shall be via exothermic welds, where possible.

K. Connectors, Fittings, Fasteners, and Hardware
1. Provide all connectors, fittings, fasteners, hardware, clamps, guards, lugs, exothermic welds, etc., as required to connect, and install all parts of the system. All equipment shall be fabricated from copper and/or bronze material

L. Installation-General
1. Installation shall be accomplished in a professional manner by an installer of verifiable ESE system installation.
2. All work installed within the building shall be concealed.
3. All work installed in accessible locations shall be properly guarded and protected.
4. All material shall be installed in a manner to prevent electrolytic action under presence of moisture.
5. All roof, wall or other building penetrations shall be made in a manner to prevent the ingress of water or moisture. Roof penetrations shall be furnished and installed by the roofing contractor.
6. PVC sleeves shall be provided where conductors pass through all floors; furnished and installed by others.

M. Manufacturer
1. The Lightning Preventor System shall be manufactured by Lightning Preventor of America, Inc., Model No. 2005 or approved equal(Protected Radius, 328 ft.), telephone number 800 421-6141.

2.25 STANDBY ELECTRICAL SYSTEM

A. Provide one 400KW, 500KVA at .8 PF standby power rated diesel fueled generator set, mounted in perfect alignment on an all welded, fabricated steel sub-base which shall allow for attachment of all necessary engine and generator accessories.

Acceptable Manufacturers:

Kohler
Caterpillar
Onan/Cummings
Generac
Baldor
MTU Onsite Energy

B. Engine

Water cooled with unit-mounted radiator. Provide starter and all field wiring required by manufacturer

Dry-type replaceable element air cleaners.

Full flow lube oil filters and bypass oil filter.

Twelve (12) volt starting motor, 12 volt, 3 ampere battery charging alternator.

Engine instrument panel to include ammeter, lube oil pressure gauge, lube oil temperature gauge, water temperature gauge, and hour meter.

Engine-mounted safety control to provide alarm signals for engine shutdown in event of low oil pressure, high coolant temperature, overspeed, over crank, and pre-alarms for high water temperature and low oil pressure.

Jacket water heater, 2000 watt, 120 or 208 volt, single phase or as recommended by generator manufacturer.

C. Generator: 400KW, 500KVA, 277/480 volt, 3 phase, 4 wire, 60 Hz, 1800 RPM revolving field type main generator with brushless exciter and permanent magnet.

Voltage regulation ± 1% from no load to full load.

D. Cooling System: Unit mounted radiator with flange attached.

E. Starting System: 12 volt heavy duty lead acid storage battery, connected for 12 volt DC output.

Battery rack, cables, and connectors shall be provided.

Provide 10 amp battery charger fed from a 120 volt, single phase, 60 Hz service. Battery charger to include high and low battery voltage alarm relays for derangement panel. Battery charger shall meet NFPA 110 Standards.

F. Exhaust System: Furnish one Maxim M-51 3" critical silencer, 3" side inlet, and one 3" end outlet complete with two (2) 3" companion flanges. Furnish one 3" x 18" flexible stainless steel exhaust connector, flanged on one end, threaded nipple on opposite end. Generator shall meet all applicable emission standards.

G. Vibration Isolators: Set of four (4) Korfund rubber type vibration isolators for installation between steel base and concrete foundation.

H. Generator Control Panel:

1. To completely control operation of engine generator set. Panel to have automatic start control, AC volt meter, AC ammeter, pointer type frequency meter, volt meter, ammeter and selector switch. Alarm signals to indicate pre-low oil pressure, pre-high coolant temperature, and alarm signals to shut down engine in event of a low oil pressure, high coolant temperature, engine overspeed, or overcrank. Lights on face of panel to indicate failure. Provide dry contacts for remote disarrangement signal & louvers. Locate remote annunciator in administration area.
2. Terminal strip shall be included with alarms and prewarning devices prewired for remote annunciator specified herein. Provide wiring between generator and remote annunciator panel. Generator control switch shall be mounted on control panel face. A flashing light for selector switch "OFF" shall be included.
3. Provide molded case line circuit breakers mounted on generator in oversized terminal box.

I. Automatic Transfer Switches:

1. Provide automatic transfer switches as shown on drawings for operation on 277/480 volts, 3 phase, 4 wire operation. Units to be housed in a NEMA 1 enclosure and shall be 4 pole. Transfer switches over 400 amperes shall have an AIC rating of 65,000 ARMS.

   Transfer switches 400 amperes or less shall be rated for 42,000 ARMS and fed from a current limiting breaker on the normal side.

   Entire switch shall be listed under UL 1008.

   Acceptable Manufacturers:

   Russ Electric

   ASCO

   Kohler
2. Unit shall be provided with standard accessories as follows.
   a. Voltage and Frequency Sensing:

3. Close differential voltage sensing on all phases of normal pickup adjustable 85-100%. Dropout 75-98%
4. Voltage sensing of emergency source. Adjustable pickup 85-100%.
5. Frequency sensing of emergency source. Adjustable pickup 90-100%.
   a. Time Delays:
6. Time delay to override momentary normal source outages. Adjustable 0.5 to 6 seconds.
7. Retransfer to normal with 5 minute cooldown timer.
   a. Engine Control:
8. Contact to close when normal source fails.
9. Contact to open when normal source fails.
10. Test switch to simulate normal source failure.
    a. Indicators: Pilot lights to indicate switch in normal position or emergency position.
    b. Auxiliary Contacts: Two (2) to close on normal. Two (2) to close on emergency.
11. Optional Accessories:
    a. Plant exerciser.
    b. Option 27 – In-phase monitor (Motor Load Transfer). (ATS-OS)
    c. Option 6A – Manual transfer to normal source.
    d. Number 31A – elevator control transfer module. A load control circuit consists of two (2) sets of single pole, double throw contacts that operate 3 seconds before transfer in either direction. Contacts rated 3 amperes, 208 volts AC or 10 amperes, 32 VDC, for signal to elevator of generator power available. Provide 2 #14AWG conductors in 3/4" conduit, interlock wiring to each elevator controller from each switch controlling elevator power.

J. Remote Annunciator Panel: A flush mounted panel shall include a visual signal that battery charger is functioning properly and both audible and visual signals. Annunciator shall meet NFPA 110 Standards.

Audible signal shall have a silencing switch. A lamp test button shall be provided.

K. Factory Testing: A certified factory test to be conducted at 1.0 power factor. Test for four (4) hours, one hour each at 25%, 50%, 75% and 100% load. Take standard readings and submit test reports for approval prior to shipment. Also, perform a field test with load bank at same ratings for 2 hours, in addition to the 2 hour load test specified below.

L. Miscellaneous: Necessary lube oil and anti-freeze.

M. Equipment Testing and Instruction Manual and Drawings:
1. Operating instructions and maintenance manuals shall contain the following information:

   Operating Instructions

   Replacement Parts

   Wiring Diagram

   Maintenance
2. The entire emergency system shall be field test operated for two (2) hours. A normal power failure shall be simulated. The engine generator unit shall automatically start, come up to speed, and assume full emergency load. Entire building shall be in operation during test.
3. Custodians of the equipment shall be present during test. At that time they shall be instructed in operation and maintenance.
4. Upon completion of tests, written reports containing results shall be submitted. Test reports shall contain readings taken at 30 minute intervals along with all other pertinent test information.

   Ambient Temperature
   Oil Pressure

Battery Charge Rate
AC Volts
AC Amperes All Phases
Frequency
Kilowatts
Power Factor

N. Coordination of Trades:
1. The following equipment shall be furnished by Electrical Contractor but shall be installed under other sections.
   a. Anchor bolts to be installed by General Contractor based on approved shop drawings.

O. Generator Outdoor Housing
1. The engine generating set shall be factory installed in a weatherproof outdoor housing. The housing shall provide year round generating set protection against adverse weather and environmental conditions. The enclosure shall be sound attenuated and meet Federal Specifications.
2. The weatherproof shelter shall be constructed or welded and bolted of reinforced aluminum, 14 gauge walls and 14 gauge floor plate. All metal parts shall be prime coated and finished painted.
3. The shelter assembly shall have shuttered air openings on front and sides with mesh screens covering side shutters. The air shutters shall be opened by four 22 volt AC motors when the generating set operates. Motors shall be spring loaded to close shutters when set stops.
4. Hinged double doors on each side and one door in rear of the shelter shall allow easy access to engine generator and controls. All door handles shall be key lock design.
5. Vibration isolators of the open coil spring type, selected for 3 inch (76mm) static deflection, shall be furnished and installed. The number of isolators shall be as recommended by the generator set manufacturer, and complete details shall be included in the Submittals. Anchor bolts, nuts and sleeves shall be supplied with recommended Foundation Plan.
6. Provide an integral 2,000 gallon base mounted tank, double wall containment with alarms. Include conduit entry provisions for tank. Tank shall be supplied in accordance with the state Fuel Storage Codes for above ground diesel fuel tanks. Provide 500 gallons of diesel.
7. The weatherproof housing shall allow installation of the silencer outside or inside the enclosure. Provide critical type silencer.
8. Provide sound deadening materials, baffles, hoods, etc. to reduce noise levels to 75DBA at 7 meters in any direction.

2.26 FIRESTOP SYSTEMS:

A. General: Provide firestopping at all fire-rated construction where penetrated by the Work of this Section.

B. Refer to Section 078400 – Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.27 STAGE LIGHTING AND DIMMING SYSTEM

A. The Electrical Contractor, herein also referred to as the EC, shall provide all labor, materials, services, and equipment to set, install, interconnect, and test the dimming and control systems as shown on the drawings and as specified herein. Drawings, specifications, and other related documents shall apply to all work.

B. Work of this Section includes, but is not limited to, the following:
   1. Installation of wiring devices, back boxes, panels, conduits, wiring, dimmer racks and modules, signal cables, DMX splitters, and architectural processor provided by others, including:

Division of Responsibilities	Electrical Contractor		Stage Lighting Contractor, Section 116100	
ITEM	Furnish	Install	Furnish	Install
High voltage conduit and wire (Line Voltage)	X	X		
High Voltage wire terminations	X	X		
High voltage wire testing and labeling	X	X		
Stage Emergency Lighting Transfer switch		X	X	
Installation of stage ECR rack and power		X	X	
Conduit for ECR rack low voltage devices	X	X		
Labeling back boxes and conduit	X	X		
Dimming System Low voltage conduit and back boxes	X	X		
Low voltage wire for dimming system		X	X	
Termination of Dimming system low voltage wire			X	X
Dimming System Control wire continuity, testing and labeling			X	X
Low voltage wire for Fire alarms, security or other	X	X		
Conduit, raceways and interconnecting boxes	X	X		
Junction Boxes	X	X		
Audience area Batten Hoists			X	X
Stage area Batten Hoists			X	X
Provide Power feed and terminations to audience area Batten Hoists.	X	X		
Provide Power feed and terminations to stage Batten Hoists	X	X		
Provide conduit for batten hoist controls	X	X		
Mount Batten hoist control stations		X	X	
Low voltage wire and controls for audience area batten hoists	X	X		
Low voltage wire and controls for stage area batten hoists	X	X		
Stage Dimmer Racks or cabinets		X	X	
Provide terminations for all dimmer load circuits	X	X		
Theatrical Control Devices			X	X
Architectural Control - House lighting back boxes		X	X	

Stage Circuit Distribution Raceways and Boxes		X	X	
Mounting of Stage Circuit Raceways to battens			X	X
Theatrical Lighting Fixture Installation and testing			X	X
Theatrical Lighting Fixture Focus			X	X
Stage & House Lighting Initial programming			X	X

2. Coordination with the System Integrator for a complete theatrical dimming system.
3. All power distribution devices, conduit and wire as required in this Section and related Specification Sections listed herein.
4. Provide all disconnects and power feeds as required for dimmer racks
5. Provide continuous liaison with the General Contractor (GC) and other trades during demolition, construction, and coordinate delivery schedules and installation of equipment.
6. The EC shall provide coordination drawings for approval showing all elements of the items in this section in an AutoCAD® file Release 12 or more recent due prior to the installation of any materials on site. This drawing shall be executed using a cross-reference of the appropriate areas of the building as a background supplied by the Architect. Minimum drawings shall include plan and section of pertinent areas noting panels, conduit size, elbows, bends and wiring devices. All elements of this drawing shall be on no more than three layers all prefixed with "-ELEC". All items shall be drawn full size with "color by layer". Hard (paper) and soft (digital) copies of this file shall be requested and used by the Architect and Theatre Consultant.
7. Materials shall be as specified under Division 260000
8. This specification shall be considered as an outline form and other appurtenances that may be required for the efficient and safe operation of the dimming and control systems specified in this section shall be furnished by the EC, the same as if specified herein.
9. All work shall be manufactured and installed in accordance with the latest editions of applicable publications and standards of the following organizations:
   a. National Electric Code (NEC) and all prevailing local regulations
   b. Underwriter's Laboratories, Inc. (UL)
   c. National Electrical MFRS. Association (NEMA)
   d. Federal Communication Commission (FCC)
   e. United States Institute of Theater Technology (USITT)
10. The EC shall provide all mounting and mechanical installations and shall verify all mounting conditions.
11. Any materials installed which shall not present an orderly and reasonably neat or workmanlike appearance shall be removed and replaced when so directed by the CM at the EC's expense
12. Any quantities, measurements or dimensions listed or shown are for the convenience of the EC in the preparation of his estimate, but will not relieve the EC of his responsibility for the determination of the exact measurements required for a complete job.

C. System Outline
1. The theatrical dimming system consists of wiring devices, both low and line voltage, theatrical dimmer rack, lighting control rack and remote consoles.
2. The DMX 512 control signal shall be generated by various consoles and devices, and shall be connected to the dimmer racks via conduit runs and appropriate low voltage cables specified herein. Access to the DMX network shall be provided via the Lighting Control Rack (LCR).
3. All equipment shall be the coordinated system integrated by the SI in coordination with the EC.

4. The specified dimming and control components are called out in terms of products as manufactured by Electronic Theater Controls, Electronics Diversified, Union Connector and others. This equipment is fully described in the Contract Documents. Complete technical data is also available from the manufacturers. All catalog numbers are those shown on Manufacturer's data sheets and drawings unless otherwise noted.
5. The dimming equipment, wiring devices and control devices shall be set into place and installed by the EC. It shall be the EC's responsibility to run all conduit and wiring for line and low voltage circuits, and make only line voltage terminations at the wiring devices.
6. When the EC is finished, a fully working and tested system will be turned over to the Owner. If mention has been omitted of any items of the work or materials usually furnished for, or necessary to the completion of the electrical work or if there are conflicting points in the specifications and/or drawings, the Architect's attention should be called to such items in sufficient time for a formal addendum to be issued.

D. System Commissioning
1. At no time shall the equipment furnished be energized prior to the SI authorized commissioning
2. The EC shall notify the SI within at least two weeks time for system commissioning.
3. The EC shall confirm in writing that the following conditions have been met prior to scheduling system commissioning.
   a. Arrangements shall be made for access to all equipment. Scaffolding, lifts or any other OSHA approved method shall be acceptable.
   b. All dimmer racks shall be installed and wired.
   c. All control wire shall be installed.
   d. All distribution equipment shall be completely installed.
   e. Continuity checks for the entire system shall have been performed and failures remedied.
4. At the time of commissioning the EC shall provide a representative who is has full working knowledge of the system, device placement and job conditions. This representative shall be on-site throughout the commissioning process and shall coordinate with, and aid, the SI to expeditiously commission the system.

E. Inspection and Testing
1. Field Check-out & Final Approvals
   a. Furnish all equipment and instruments necessary for testing the complete wiring system during the progress of the work as well as after installation. Tests shall be demonstrated to the satisfaction of the Owner. Test the following:
      1) All circuits are continuous and free from short circuits
      2) All circuits are free from unspecified grounds
      3) All circuits are properly connected in accordance with the applicable wiring diagram
      4) Voltage drop at each end of the circuit with a 2000 watt load
      5) All low voltage circuits complying to industry standards
2. Final check of House, Work and Stage control system
   a. All work under this contract, upon completion of installation, shall be demonstrated, tested and adjusted in coordination with the SI and the EC. No part of the system shall be energized before being so checked and the installation approved.
   b. Make all necessary arrangements for all parties concerned to be present, by scheduling such inspection in a manner acceptable to the Theatre Consultant and give a minimum of 14 days notice.
   c. Furnish all labor, materials and instruments necessary for this inspection and testing.

3. Final site visitation by the Theatre Consultant
   a. When the work on the entire structure has been completed and is ready for final review, a visit will be made by the Theatre Consultant or his duly authorized representative, at which time the SI shall demonstrate that the requirements of the contract as it applies to his work have been carried out and that the system has been adjusted and operates in accordance therewith.
   b. Any defects shall be repaired at once and the tests re-conducted.

2.28 TV STUDIO DIMMING CONTROL AND LIGHTING SYSTEM

A. Acceptable Manufacturers
   1. The equipment herein specified shall be manufactured by Electronic Theatre Controls (ETC).

   2. Strand and Entertainment Technology are considered equals. It is the sole responsibility of the electrical contractor to ensure that any submittals made are for systems that meet or exceed the specifications.

B. Installation Dimmer Rack
   1. General
      a. The installation rack shall be the Sensor as manufactured by Electronic Theatre Controls, Inc., or equal. The fully digital dimmer rack shall consist of up to 24 dual-dimmer module spaces. Sensor rack systems shall be UL Listed and CSA Approved, and shall be so labeled when delivered to job site.
   2. Electrical
      a. Sensor racks shall operate at up to 120/208V, three phase, four wire + ground, 47 to 63 Hz at 200 amps max. Provisions shall be made for optional amp trap devices for fault current protection. Standard AIC fault current protection shall be 10,000.
      b. All load and neutral terminals shall accept up to a #3/0 AWG wire.
   3. Electronics
      a. Dimmer control electronics shall be contained in one plug-in Control Electronics Module (CEM). Each CEM shall contain no discrete wire connections, and be housed in a formed steel body with an injection-molded face panel.
   4. Physical
      a. The Sensor dimmer rack shall be a freestanding, deadfront switchboard, substantially framed and enclosed with 16-gauge, formed steel panels. All rack components shall be properly treated, primed and finished. Exterior surfaces shall be finished in fine texture, scratch resistant, gray epoxy paint. Removable top and bottom panels shall facilitate conduit termination on the 48-module rack. Knockouts shall serve the same purpose on 12 and 24 module racks.
      b. Sensor racks shall have the following dimensions.
         1) SR-24 (24 module) 45.8" H x 14.8" W x 16.8" D
      c. Racks shall be designed for front access to allow back-to-back or side-by-side installation.
      d. Racks shall be designed to allow easy insertion and removal of all modules without the use of tools. Supports shall be provided for precise alignment of dimmer modules into power and signal connector blocks. With modules removed, racks shall provide clear front access to all load, neutral and control terminations. Racks that require removable panels to access load, neutral or control terminations shall not be acceptable.
      e. An optional bus bar kit shall be available from the factory to allow adjacent racks to be powered by a single line feed. No hard, rack-to-rack wiring shall be required. Racks that require discrete cabling to connect adjacent racks shall not be acceptable.

f. Module spaces shall be mechanically keyed to accept only the module type (20A, 50A or 100A) specified for that space. Racks that allow modules of varying wattages to plug into the same space shall not be acceptable. The rack shall be configurable to accept mixed dimmer types and sizes throughout the rack.

g. Each rack shall provide a lockable full-height door containing an integral electrostatic air filter that shall be removable for easy cleaning. A single low-noise fan shall be located at the top of each rack. The fan shall draw all intake air through the integral electrostatic air filter, over the surfaces of the module housing and out the top of the rack. The fan shall maintain the temperature of all components at proper operating levels with dimmers under full load, provided the ambient temperature of the dimmer room does not exceed 40°C/104°F. Dimmer racks that do not employ both locking doors and electrostatic air filters shall not be acceptable. The fan shall turn on whenever any dimmer in the system is activated. In the event of an over-temperature condition, only the affected dimmer module(s) shall shut down and a message shall appear on the control module LCD. The fan shall remain on during thermal shutdown of individual dimmer modules.

h. An airflow sensor shall be provided. In the event of inadequate airflow, the affected rack shall shut down until the error is corrected.

i. If the ambient room temperature drops below 0°C/32°F or rises above 40°C/104°F, a warning shall appear on the dimmer rack LCD. If the temperature rises above 46°C/115°F, the rack shall shut down until the condition is corrected.

j. A 3 x .5-inch LED status indicator (beacon) shall be mounted in the rack door. The beacon shall be visible throughout a wide viewing angle. In normal operation conditions, this LED is illuminated. If the rack's control module senses an error condition, the beacon shall flash until the error is corrected. An optional indicator shall be available for remote locations.

C. Dimmer Control Electronics Module

1. General

a. Dimmer control electronics module shall be contained in one plug-in Control Electronics Module (CEM). Each CEM shall plug into a dimming cabinet. Each CEM shall contain no discrete wire connections, and be housed in a formed steel body with an injection-molded face panel. The CEM shall have three phase-status LED indicators. A 25-key control pad and a two-line-by-20-character backlit LCD shall be provided for system configuration, testing and diagnostics. LCD shall also display rack status and error messages.

2. Electrical

a. Dimmer control electronics module shall operate at up to 120/208V, three phase, four wire + ground, 47 to 63 Hz. The CEM shall automatically compensate for frequency variations during operation.

3. Electronics

a. The CEM shall have three phase-status LED indicators. A 25-key control pad and a two-line-by-20-character backlit LCD shall be provided for system configuration, testing and diagnostics. LCD shall also display rack status and error messages.

b. The following keys shall be provided: ten numeric keys, [Reset], [Dimmer], [Setup], [About], [Backup], [At], [Next], [A/B], [Clear], [⇒], [⇑], [⇐], [Thru], [Enter], and [Exit].

c. The CEM shall contain the following user displays:

1) Status display to show rack identification and errors. Error Messages shall include, but not be limited to, the following:

a) Dimmer has shut down due to over temperature
b) DMX port A or B has an error or has failed
c) Phase A, B or C is below 90 volts
d) Phase A, B or C is above 140 volts
e) Rack has shut down due to improper startup voltage
f) Rack has shut down due to air flow loss

g) Ambient temperature is below 0°C/32°F
h) Ambient temperature is above 40°C/104°F

2) Rack has shut down - ambient temperature exceeds 46°C/115°F
3) Dimmer display to set a dimmer or dimmers to a level. (CEM shall allow user to set single dimmers or groups of dimmers from integral keypad.)
4) Backup display to program and activate system-wide backup looks.
5) About display shall allow monitoring of system, rack or dimmer status.
   a) About System shall provide information about Panic circuits, Backup looks and System name
   b) About Rack shall provide information about rack voltage, Start addresses, ambient temperature and rack type.
   c) About Dimmer shall provide information about dimmer size and type, location, output levels including source, recorded loads and current loads.
6) Setup display shall allow but not be limited to, configuring of rack addresses, dimmer firing mode, and scale voltage values.

d. The CEM shall respond to control changes in less than 25 milliseconds. Dimmer outputs shall exhibit no oscillating or hunting for levels. Dimmers set to the same level shall output within ±1V of each other, regardless of phase or electronic module control.

e. Dimmer output shall be regulated for incoming line voltages. The regulation shall adjust for both RMS voltage changes and deformations in the incoming AC waveform. The CEM shall monitor and adjust each dimmer's output to maintain a constant power to the load. Regulation shall maintain the desired output voltage ±1V for the entire operating range (90-140V AC) with the exception that the maximum output will be no greater than the line voltage minus dimmer insulation loss. The regulation shall compensate for dips and anomalies in the AC waveform on a dimmer-by-dimmer basis. There shall be no interaction between dimmers in the system or any other equipment. The output shall be nominally regulated to 120V, but shall be field adjustable on a dimmer-by-dimmer basis to allow for varying cable length.

f. The entire response to incoming line changes shall take no more than 25 milliseconds. Dimming systems that do not respond to line fluctuations and do not contain wave deformation detection shall not be acceptable.

g. Two optically isolated DMX512 inputs shall be provided, allowing overlapping or separation of any control level. 2,500V of optical isolation shall be provided between the DMX512 inputs and the CEM. This shall protect the DMX512 inputs from a failed control module and the CEM from failed DMX512 inputs. Systems that do not have optical isolation on a prewired factory plug-in device shall not be acceptable.

h. The CEM shall be completely digital without employing any digital-to-analog demultiplexing schemes or analog ramping circuits. Each rack shall, in the event of signal loss, maintain the last level for a user-programmable time of zero to five minutes or indefinitely. Systems that do not offer this feature shall not be acceptable.

i. The CEM shall contain diagnostic routines to allow the user to test and troubleshoot the system. The CEM shall contain a Test/Bypass switch to turn all dimmers on to full for testing. This switch shall bypass all electronics and shall force the fan on.

j. A system-wide panic circuit shall be provided. Any dimmer in any rack may be assigned to the panic circuit.

k. The CEM shall be able to record up to 32 backup looks (16 in systems exceeding 2,000 dimmers). Backup looks shall be programmable by recording current dimmer levels (as set by the console), by entering dimmer levels on the CEM directly, or a combination of both methods. When a backup look is active, the DMX512 inputs shall be ignored in the default priority mode.

l. All system functions may be activated by the CEM's integral keypad and shall not require any remote unit. Systems that do not offer this feature shall not be acceptable.

m. Through the ETCLink network, optional remote control devices shall be available.

4. Dimmer Status Network

a. The Dimmer Status network shall provide remote monitoring, programming and backup functions for the system through any Sensor-compatible console, PC, or hand-held remote device. System information shall also be displayed on any system interface including the CEM and the devices listed above. Systems that do not provide both types of user interface shall not be acceptable.

b. Dimmer Status network shall provide an integral link to connect all racks in the system for rack-to-rack communication. Information for all configuration and backup looks shall be stored in all CEM's to allow swapping of CEM's throughout the system. Systems not storing all configuration data and backup looks for each dimmer in all control modules shall not be acceptable.

c. A technician shall be able to program all parameters onsite, using a laptop personal computer. These parameters shall include, but not be limited to, defining rack type, module type, scale voltage for each dimmer, firing mode, curve, dimmer numbering and DMX512 port assignments. Systems requiring factory programming shall not be acceptable.

5. Advanced Features

a. Sensor's Advanced Features (AF) option shall add an additional sensor in the individual dimmer modules. The AF option shall allow monitoring of current and output voltage on a dimmer-by-dimmer basis and provide information on lamp burnouts, dimmer status, and input voltages.

b. The CEM shall allow the user to record the loads of all AF dimmers in the system. The CEM shall, during operation, test each AF dimmer, determine its load, and compare it to the recorded load. Any change from recorded loads greater than five percent shall display an error on the CEM and any monitoring device on the ETCLink network.

6. Physical

a. Dimmer control electronics shall be contained in one plug-in Control Electronics Module. Each CEM shall contain no discrete wire connections, and be housed in a formed steel body with an injection-molded face panel.

b. An airflow sensor shall be provided. In the event of inadequate airflow, the affected rack shall shut down until the error is corrected.

c. If the ambient room temperature drops below 0°C/32°F or rises above 40°C/104°F, a warning shall appear on the dimmer rack LCD. If the temperature rises above 46 °C/115°F, the rack shall shut down until the condition is corrected.

D. Control Console and Accessories

1. General

a. The control console shall be a two-scene preset console. Console capacity shall be 24 channels. The console shall be the Acclaim 100 series as manufactured by Electronic Theatre Controls, Inc., or equal.

b. The console shall be capable of controlling 48 dimmers. Data shall be transmitted via USITT standard DMX512 over a single cable. Consoles requiring a wire-per-dimmer analog, proprietary or multiple lines shall not be accepted.

c. The console shall have a Grand Master and blackout button.

2. Controls and Playback
   a. The manual selection shall contain 24 potentiometers arranged in two scenes of 12. A split handle cross fader shall be supplied for dipless crossfades, lead/lag and pile-on fades. Associated with each side of the fader shall be a fadetime potentiometer. Time fade progress shall be tracked by an LED display. Fade times shall be easily adjusted during a fade with the time potentiometers or overridden manually with the cross faders.
   b. The console shall have a row of channel buttons switchable from Bump to Solo made by the [Solo] button. An LED indicator shall illuminate indicating that Solo is active.
   c. Bump shall instantaneously bring a channel to full. When released, the channel will return to its original state.
   d. [Solo] shall instantaneously bring a channel to full and black out all other outputs. When released, all channels shall return to previous levels.
3. Operating Mode
   a. The Console shall include three mode buttons: [View], [Chase] and [Subs].
      1) [View] shall allow the user to display the chase on the channel button LEDs.
      2) [Chase] shall allow the user to program a series of steps, each step containing one channel, to be played back in order at a user-selected rate. The following controls are used with a chase:
         a) The Level potentiometer controls the overall intensity of the chase.
         b) The Rate potentiometer adjusts the amount of time between each step of the chase. The chase rate is variable from .1 second to1 second.
         c) The [Blackout] button blacks out the chase output.
         d) The [Reverse] button reverses the direction of the chase.
         e) The [Step] button steps through each step individually. Each press of [Step] shall increase the step number by one.
         f) The [Stop] button stops the chase at any point.
         g) [Submaster] shall allow the user to program the submasters. Eight submaster potentiometers with [Bump] and [Solo] buttons are provided.
   b. Electrical
      1) The console shall contain a 2-position switch for power On and Off.
      2) Console power shall be 90 – 240V AC at 50 or 60Hz supplied via a detachable power cord. Power supply shall be capable of sensing incoming power and adjusting appropriately. All power supplies shall be contained in the console. Consoles with separate power supplies shall not be acceptable.
4. Physical
   a. The console shall be constructed with a minimum profile of .047” steel with FR-ABS end caps. Adjustable feet provide an angled work surface for convenient operation. Finish shall be fine-texture, scratch-resistant gray powder coat with black and red silk-screened graphics.
   b. All operator controls and console electronics for a standard system shall be housed in a single desktop console. Adjustable feet provide an angled work surface for convenient operation.
      1) Acclaim 112 27”L x 13.5”D x 3”H

E. Ellipsoidal Spotlights
1. General
   a. The instrument shall be a Source Four ellipsoidal spotlight as manufactured by Electronic Theatre Controls, Inc., or equal.

2. Physical
   a. The unit shall be constructed of rugged, die cast aluminum, free of burrs and pits, finished in black, high temperature epoxy paint. Tools shall not be required for either lamp alignment or cleaning the reflector or lens
   b. The following shall be provided:
      1) Integral cable clamp for power leads
      2) Positive locking of lamp focus and independent lamp alignment controls
      3) High impact, thermally insulated knobs and shutter handles
      4) Reflector secured with shock mounts
      5) Lens secured with silicone shock mounts
      6) Rotating shutter assembly - 50° rotation
      7) 20 gauge stainless steel shutters
      8) Insulated rear handle
      9) Interchangeable lens tubes for different field angles with Teflon guides for smooth tube movement.
      10) Sturdy integral die cast gel frame holders with two accessory slots, and a top mounted, quick release gel frame retainer.
      11) Rugged 3/16" x 1-1/4" steel yoke with two mounting positions allowing 300°+ rotation of the fixture within the yoke.
      12) Positive locking, hand operated yoke clutch
      13) Slot with sliding cover for motorized pattern devices or optional iris
3. Optical
   a. The optical train shall combine a compact filament lamp with a precision molded borosilicate, ellipsoidal reflector and aspheric lens to produce an optimum cosine field.
   b. The unit shall provide, but not be limited to:
      1) Molded borosilicate reflector with multiple dichroic layers
      2) 95% of visible light shall be reflected while 90% of infrared light as heat shall be transmitted through the reflector
      3) Low gate and beam temperature
      4) Sharp imaging through a three plane shutter design
      5) Projector-quality, high contrast aspheric lens, with an anti-reflective coating to increase transmission.
4. Performance
   a. The unit shall be precision engineered to use an HPL lamp to deliver an even, intense field with cosine distribution.
   b. The unit shall provide, but not be limited to:
      1) 5, 10, 19, 26, 36, and 50 degree field angles
      2) Projector-quality pattern imaging
      3) Sharp shutter cuts without halation
      4) Shutter warping and burnout in normal use shall be unacceptable
      5) Adjustable hard and soft beam edges
   c. The unit shall be capable of utilizing ETC Dimmer Doubling technology
   d. The unit shall be UL and cUL listed and so labeled.
5. Lamp
   a. The high efficiency lamp shall be an HPL lamp, which shall consist of a compact tungsten filament contained in a krypton-filled quartz envelope. The lamp shall mount axially within the reflector. The lamp base shall have an integral die cast aluminum heat sink that reduces seal temperature and ensures proper lamp alignment. The lamp socket shall be ATP 220 nickel gold plated.

F. Installation
1. It shall be the responsibility of the Electrical Contractor to receive and store the necessary materials and equipment for installation of the dimmer system. It is the intent of these specifications and plans to include everything required for proper and complete installation and operation of the dimming system, even though every item may not be specifically mentioned. The contractor shall deliver on a timely basis to other trades any equipment that must be installed during construction.
2. The electrical contractor shall be responsible for field measurements and coordinating physical size of all equipment with the architectural requirements of the spaces into which they are to be installed.
3. The electrical contractor shall install all lighting control and dimming equipment in accordance with manufacturer's approved shop drawings.
4. All branch load circuits shall be live tested before connecting the loads to the dimmer system load terminals.

G. Manufacturer's Services
1. Upon completion of the installation, including testing of load circuits, the contractor shall notify the dimming system manufacturer that the system is available for formal checkout.
2. Notification shall be provided in writing, two weeks prior to the time factory-trained personnel are needed on the job site.
3. No power is to be applied to the dimming system unless specifically authorized by written instructions from the manufacturer.
4. The purchaser shall be liable for any return visits by the factory engineer as a result of incomplete or incorrect wiring.
5. Upon completion of the formal check-out, the factory engineer shall demonstrate operation and maintenance of the system to the owner's representatives. Training shall not exceed four working hours. Additional training shall be available upon request.

H. Warranty
1. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two years from date of delivery.
2. Warranty shall cover repair or replacement of such parts determined defective upon inspection.
3. Warranty does not cover any product or part of a product subject to accident, negligence, alteration, abuse or misuse. Warranty does not cover any accessories or parts not supplied by the manufacturer.
4. Warranty shall not cover any labor expended or materials used to repair any equipment without manufacturer's prior written authorization.

Provide the following:

The system shall consist of the following:

Qty.	Model #	Description	Item #
I. ENTERTAINMENT DIMMING			
(1)	SR25+	Sensor 24 Module Rack(s)	
(1)	CEM-48	Control Electronics Module(s) – 48 Dimmers	
(24)	D-20E	Dual 20A Dimmer Module-500uS	7050A1003

II. ENTERTAINMENT CONTROLS			
(1)	SF2496	Smartfade 2496	7219A1002
(2)	CD25-DMX	25' DMX Control Cable	1085A1002
(2)	ECPB	DMX-Interface	1076A1014
III.DISTRIBUTION			
(6)	9104A	4 Circuit Surface Mount Outlet Box – U-Ground	7099A1104A
FIXTURES			
(6)	450-A	Source Four 50º Ellipsoidal(s) w/C-clamp, color frame, Edison conn.	7060A1010-A
(4)	Soft-Lite Jr	Altman Softlight-Lite Jr w/QI/SL-25S,526/3-5 Floor Base, Lamp	Soft-Lite JR
(8)	650-SM	Altman 4-1/2" 650 watt Fresnel/Stand Model	650-SM
(8)	F4-BD4	Altman 4 leaf Barn Door	F4-BD4
(4)	650-FM	Altman 4-1/2" 650 watt Fresnel/Stand Model	650-FM
(4)	F4-BD4	Altman 4 leaf Barn Door	F4-BD4

2.29 EQUIPMENT CABINETS

A. Provide equipment cabinets to house all security equipment, communication equipment, telephone/data equipment, and audio visual equipment. Racks shall be located as shown on the drawings.

B. Manufacture: Provide products meeting the requirements of the Drawings and Specifications from one of the following Manufacturers or equal:
   1. Chatsworth, Great Lakes.
   2. Winsted
   3. Lowell

C. Equipment Cabinets
   1. Equipment Cabinets shall be seven feet (2134 mm) high, 24 inches (600 mm) wide, 31.5 inches (800 mm) deep, free standing cabinets as indicated on the drawings. These cabinets are also known as Primary Distribution cabinets, Remote Distribution cabinets, CCTV cabinets, AV cabinets, etc. Cabinet features shall include the following:
      Cabinets shall be welded construction, steel or aluminum, piano hinged doors with keyed locks and access handles on front and rear. Door locks shall be keyed alike. Color shall be approved by the Architect. Front door shall have integral shatter proof vision panels in a metal frame.
      a. Integral EIA nineteen inch (518 mm) wide, open bay equipment rack. Rack shall be as described herein this specification. Rack shall be located within the cabinet in order to properly mount all passive and active electronic components.
      b. Shelves for electronic equipment with load carrying capacity to support at least 125 percent of each piece of electronic equipment weight. Shelves shall have adequate openings within them to dissipate heat and allow for adequate electronic equipment ventilation.

c. Mounting brackets specifically designed to support the equipment installed within the cabinet.
d. Hook and loop (Velcro) cable strain relief system on rear of rack to support horizontal and backbone cables. Tie-wraps are specifically prohibited.
e. Hook and loop (Velcro) horizontal and vertical cable management on front of rack to support patch cable and cross connect wiring. Tie-wraps are specifically prohibited.
f. Hook and loop (Velcro) cable management system independent of telecommunications cabling management to properly dress the electronic equipment power cords through the cabinet maintaining as much clearances between the two as possible. Tie-wraps are specifically prohibited.
g. Cabinets are to be design for convection ventilation, no fans shall be used. The individual cabinet shall have adequate ventilation in order to have a temperature within the cabinet be no greater than 88 degrees F based on an ambient room temperature of 78 degrees F in the warmer months of the year and 68 degrees F in the colder months of the year.
h. Bonding and grounding cables for all equipment not directly bolted to equipment rack (i.e shelf mounted electronic equipment, etc.).
i. Bonding and grounding buss bar with individual set screw terminals for at least six #6 Cu. bonding cables.
j. Surge protected power strip as described in this specification.
k. Patch panels as described in this specification.
l. Blank/louvered panels where required to fill gaps between equipment within the rack.
m. All hardware, supplementary steel, channel and supports as required to properly assemble the cabinet and support it to the building structure.

2.30 COMPANY SWITCHES

A. SPECIFICATIONS

1. The Company Switch shall be a specialized power distribution panel for the connection of portable electrical equipment in theaters, auditoriums and other entertainment venues (interior and exterior).
2. The Company Switch must satisfy the requirements of NFPA 70 (National Electric Code): Article 408 - Switchboards and Panelboards • Article 520 - Theaters, Audience Areas of Motion • Picture and Television Studios and Similar Locations Article 530 - Motion Picture and Television Studios • and Similar Locations.

   Output panel connectors must specifically comply with Section 520.53(K) for Single-Pole Separable Connectors and Section 300.20(B) Induced Currents in Ferrous Metal Enclosures. The entire assembly must be uL listed and labeled.
3. The Company Switch shall be a 24" W x 36" H x 9" D, NEMA 3r, wall mounted enclosure constructed of 14 and 16 gauge steel finished with a black polyester powder paint. Outdoor units shall be mounted in lockable, NEMA 3r, free standing enclosures with lockable, piano-hinged doors.
4. The main breaker shall be a uL listed, 100% equipment rated, continuous-duty circuit breaker utilizing a thermomagnetic over-current protective trip system. It shall have a CSA/UL short-circuit interrupting rating of 50kA at 240VAC.
5. All connections from the main breaker and the input lugs to the outlet receptacles shall be made with flexible copper buss bar. The grounding connection shall be made to the main cabinet frame. Service input to the cabinet shall be 120/208 VAC, three phase, 4 wire + ground.

6. Phase indicator lamps shall be mounted in a clearly visible location on the front panel of the enclosure. A safety interlock mechanism shall prevent the door to the enclosure from being opened if the breaker is on. An additional locking mechanism shall allow a padlock or lockout tag to secure the breaker in the OFF position.
7. The NEC mandated warning advising the proper sequence for connecting and disconnecting single pole separable connectors shall be permanently printed on the front of the enclosure.
8. The Company Switch shall be hipot tested at 1250VAC.
9. Provide non-ferrous output panel at the bottom of the enclosure with C/BW (5) Panel Mount Cam receptacles with snap-back covers and (5) internal lugs for bare wire cable connections with individual strain relief fittings for each load cable.
10. Standard company switches are provided with female receptacles for A, B & C phases and male receptacles for neutral & ground.
11. Provide a quantity of four (4), 200A Model 600 Series Company Switches.

2.31 SURGE PROTECTED POWER STRIP

A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following Manufacturers:
   1. Wiremold Sentrex, TrippLite or S.L. Weber.

B. Surge protected power strip shall be rack mount type with 10' cord.

C. Surge protected power strip with six NEMA 5-15R outlets 15 amp capacity, 120 volts, UL 1449 listed, maximum surge current of 33,000 amps, clamping voltage of 260 volts, maximum 5 picosecond response time, resettable overload circuit breaker, surge suppression warning light, surge protection for line to neutral, line to ground, neutral to ground, EMI/RFI filters. One required for each load up to 1200 watts (total of individual equipment loads).

2.32 CABLE SUPPORTS

A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturer's:

J-Hooks:	Caddy, Chatsworth, Mono-System.
Hook and Loop Fasteners:	Chatsworth, Ortronics, Siemons.
Cable Ties:	DEK, Panduit, Amp, 3M, T&B.
Beam Clamps:	Burndy, Minerallac, Kindorff, Steel City, OZ/Gedney.
Split Mesh Strain Reliefs (Kellums):	Hubbell, Woodhead.

B. J-Hooks shall be sized to correctly support the number of cables, which pass through them. Under no circumstances shall cable quantity exceed 50 in any given support. Fill capacity shall be as required by code for conduit. That is to say that every J-Hook shall have a maximum of 40 percent fill capacity. Install additional supports as required.

C. Hook and loop fasteners shall be designed for their specific application. For example, if a hook and loop fastener is used to support cables to a rack, it shall have a grommeted outlet for use with a 10-32 rack mounting screw.

D. Cable-ties shall be correctly sized to support the quantity and types of cables installed.

E. Beam clamps shall be steel with threaded bolt type closure. Spring steel or "quickclip" type clamps are prohibited.

F. Split mesh strain reliefs shall be properly sized for each cable that they support. Only one cable shall be installed in each split mesh strain relief.

2.33 CABLE HANGING SYSTEM

A. All lighting, branch circuitry and other equipment within load limits shall be supported using wire rope cable terminated by the cable locks manufactured as described below.

B. Zinc Housing- One piece die cast Zinc alloy to provide major anti-corrosion properties and strength.

C. Locking Wedges- An oil impregnated sintered steel locking wedge seated in each of two channels. Both wedges incorporate a release pin for easy adjustment.

D. Stainless Steel Springs- Each spring is manufactured of stainless steel and insures initial engagement of the locking wedge to the wire rope.

E. Safe Working Loads: Ultimate Breaking Strength (UBS) shall be 5 times the published Working Load Limit (WLL)

F. Independent Testing- All cable locks and wire rope shall be independently tested to five times their allowable working load and carry approval by: UL, SMACNA, RADCO and NY Testing Laboratories.

G. Manufacturer: RIZE Enterprises based in Brentwood, NJ, Copper B Line, Erico, or equal.

2.34 BONDING AND GROUNDING JUMPER CABLE

A. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturers:
1. Belden (No. 8669) or equal.

B. Jumper cable shall be hollow braided, 60 amp capacity, copper.

C. Provide equal conduct of as described in "B" above for aluminum equipment.

D. Jumpers shall have compression or exothermic type terminals on both ends of cables. Terminals shall be compatible with jumper cable material and equipment material in order to not have any degenerative reaction.

2.35 UNSHIELDED TWISTED PAIR (UTP) CABLING SYSTEMS

A. Provide all security data cabling as specified herein and shown on the Security drawings. The security cable and jacks shall be red in color.

B. Manufacturer: Provide products meeting the requirements of the Drawings and Specifications from one of the following manufacturer's or equal:

Wire and Cable:	Belden, Berk-Tek, CommScope, General Cable, Mohawk.
Patch Panels:	Hubbell, Ortronics, Panduit
Patch Cables:	Shall be provided by patch panel, Outlet or wire and cable manufacturer.
Cable Management:	Shall be provided by patch panel manufacturer.

NOTE: Each of the products listed above shall be provided by a single manufacturer.

C. UTP Pin/pair Termination Assignment
1. The UTP cabling systems shall have EIA/TIA 568B Series standard pin/pair termination assignment. All conductors provided shall be properly and consistently terminated at both ends throughout the entire systems.

D. Horizontal Cable –Security Data
1. Provide & terminate cabling from each camera location to applicable IDF/MDF/Low Voltage rack locations.
2. Data Cable shall be TIA/EIA-568-B.2-1 Category 6 Unshielded Twisted Pair (UTP) as specified.
   a. Cable shall meet or exceed the approved TIA/EIA-568-B.2-1 Category 6 Unshielded Twisted Pair (UTP) cable standard for 24AWG four pair Category 6 cable.
   b. Acceptable equal cables shall be General Cable Command LINX 6; and GenSPEED 6000 Category 6 cables.
   c. Plenum rated cable - CMP rated jacket for Plenum applications.

E. Cable Management
1. Each equipment rack and equipment cabinet shall have cable management panels with horizontal and vertical brackets.
   a. Cable management shall be EIA nineteen inch (518mm) rack mounted 3.5 inch (88mm) high panel with horizontal and vertical patch cable, distribution rings, or approved equivalent and shall be provided above and below each patch panel in the equipment rack.
   b. Equipment rack cable management shall be furnished by patch panel manufacturer.
   c. Cable management for high density, IDC Type cross-connect block panels shall be distribution rings integral to the panel or approved equivalent. Cable management shall be provided above and below each cross connect block in the equipment rack.

F. Modular Jacks
1. Jacks shall be TIA/EIA Category 6 (UL Category 6) with printed circuit board technology and integral board mounted, color-coded, high density, IDC type terminations. Provide 8 position modular jacks. Keyed jacks are not allowed. Jacks shall be able to withstand at least a minimum of 2000 mating cycles without any transmission degradation.
2. Modular jacks color shall be red.
3. Each 8-position modular jack shall have color-coded icons.
4. Modular jacks that allow pre-connectorized cables to be connected to the jacks are specifically prohibited. Cables shall have single point IDC Type connection to the jacks only.
5. Jack modules shall be flame retardant thermoplastic with integral cable strain relief. Color shall match faceplate.

G. Data Patch Panels for Security
1. Patch panels shall be EIA nineteen inch (518mm), rack mounted, TIA/EIA Category 6, UL Category 6 type patch panels with integral printed circuit board, color-coded, high density, IDC type terminations and 8 position modular jacks. Keyed jacks are not allowed. Jacks shall be able to withstand at least a minimum of 2000 mating cycles without any transmission degradation.
2. Provide high density rack mounted patch panels.
3. Modular Jacks that allow pre-connectorized cables to be connected to the jacks are specifically prohibited. Cables shall have single point IDC type connection to the jacks only.
4. Each port shall have color-coded identification label. Continuous label strips for multiple in-line ports are acceptable. Silk screened identifiers "l" through "96" are acceptable.
5. Patch panel shall have horizontal strain relief bar on mounted rear.

H. Patch Cables and Line Cords
1. Patch cables and line cords shall be factory pre-connectorized, TIA/EIA Category 6 (UL Category 6), 4 UTP, 8-position modular jack, stranded conductors. Patch cables and line cords shall be able to withstand at least a minimum of 2000 jack mating cycles without any transmission degradation.

I. Cross Connect Cabling
Cross-connect cabling shall be NRTL certified that it meets or exceeds the TIA/EIA UL category rating of the system installed.

2.36 MISCELLANEOUS CABLING SYSTEMS (for Security, Intercom, Microphones, etc.)

A. Provide and terminate all speaker, microphone, card reader, cell check processor, duress button, duress strobe, antenna, cameras, etc. cabling per manufacturers recommendations for a completely operational system as specified.

B. CCTV System Cabling, provide cabling as required for a completely operational CCTV System.
1. Camera cabling:
a. Provide and terminate cabling between camera locations and Head End location.
b. Each IP camera shall be connected to its respective network switch using CAT6 cable as specified elsewhere in this specification.
c. Provide additional cabling as required per manufacturer's recommendations.
2. Keyboard/Mouse cabling:
a. Provide cabling as required per manufacturer's recommendations.

C. Access Control System.
1. Proximity Card Reader; the cable requirements of the card reader shall be a minimum five (5) conductor, 18 AWG, stranded cable with overall shield. A six (6) conductor cable is required when controlling the red and green LED individually. A seven (7) conductor cable is required when both the red and green LED's are controlled by the Host. A 22 AWG twisted pair, shielded, stranded cable is required for use of the tamper switch. The card reader shall be provided with a 10 wire pigtail connector.
2. Door Contact: the cable requirements for a door contact is 22 AWG. Wire to line monitoring module at each door.
3. Request-to-exit device; for every request-to-exit symbol shown, provide 2/18 AWG to security control power supply and 2/22 AWG to line monitoring module at each door. Home run all cable to the access control panel.
4. Line Monitoring module: Provide 2/18 AWG shielded for each line monitoring module and home run to the security control panel.

5. Electric lock; Provide 2/14 AWG per every door locking device. Home run all cabling for the electric strikes to the electric strike power supply. Home run all cabling for the magnetic locks to the magnetic lock power supply. The electrical contractor shall furnish 120 VAC where necessary.

2.37 SECURITY NETWORK SWITCHES

A. General
1. Provide active network switches for all cameras, access control panels, speakers, encoders/decoders, interview rooms, security workstations, security monitoring workstations, interview room workstations, video servers, and access control servers.
2. Each network switch shall be located in MDF.

B. Products
1. Provide Power over Ethernet (PoE) network switch(s) for all IP cameras.
2. Each switch shall have 20% spare capacity.
3. PoE network switches must support by same manufacturer a redundant power supply option. Though not a requirement at this time, proposed network switches must have this option without replacement of network switches.
4. Provide HP ProCurve Stackable Switches or equal.
5. Switches to be provided with lifetime warranty.

2.38 INTEGRATED COMMUNICATION AND DOOR SYSTEM

A. Systems Description
1. The system is a combination audio and video intercom system. Intercom stations and intercom master stations shall be audio and video intercom system.
   a. Aiphone (IP type) shall be an acceptable manufacture for the audio/video intercom system.
2. The purpose of the building security intercom system shall be to provide clear, two-way, remote reply intercommunication between the intercom master stations and remote intercom stations.
3. System shall be a direct-selection type with an individual electronic push button and LED annunciation, on the master consoles, for each substation in the system. Shall also include direct-select electronic buttons and LED's for all functions.
4. System(s) shall be microprocessor controlled, with individual (1) pair cable between master(s) and substation(s). System shall provide hands-free, remote reply at the receiving (substations). Microprocessor shall provide flexibility of features and functions through programming, and shall include two serial output data ports to allow direct interface and transfer of call processing functions to related microprocessor systems. One output port shall provide serial data that includes: call placed by substation, call answered by master, press-to-talk button activated, call canceled (reset) by master, and group call activated by master. NOTE: External equipment must match protocol or provide a protocol converter. Input port shall be able to receive serial data to simulate placing of a substation call (flash appropriate green LED and sound tone).
5. System capacity shall allow interconnection of multiple masters and multiple substations. Base Bid standard masters shall be able to add modules and boards to direct-select call, and communicate with, up to (7) other master control stations and up to (96) substations.
6. Scope of system shall include all features and functions described herein and all equipment shown on the plans. System shall be capable of adding optional features and components listed in specifications, even if not initially included or shown on the plans.
7. The extent, size, locations, and layout of the system shall be as shown on the plans.
8. A complete and operational system shall be provided.

B. Acceptable Manufacturers
   1. The system described herein is based on the P-9600 system as manufactured by Zenitel USA/ STENTOFON. Additional manufactures are as follows:
      a. Genetec
      b. AiPhone, AI series
      c. Or Equal

C. System Configuration
   1. Standard intercom master control station(s) shall be located as required and shown on the plans. The master stations shall be an integral component of the integrated security solution and shall be sized appropriately according to the number of annunciated direct-select substation buttons as required in each area.
   2. The appropriate number of power supply(s), MDF connection blocks, page adapters, interfaces, multiple master connection units, and accessories shall be wall mounted in a secure area such as a telephone closet or electrical room, as shown on the plans.
   3. Indoor tamper resistant substations shall be flush wall mounted, outdoor and parking garage tamper resistant stations shall be surface wall mounted or in stainless steel weather resistant housings with lamp indicators, and elevator substations shall be installed behind the car operating panels, as shown on the plans.
   4. Provide integration with the Integrated Security System to allow camera call up when a specific intercom and/or duress button is deployed. Each duress button shall be logged into the access control database.
   5. All locations within the detention area shall support the configuration of an audio threshold. Upon the breach of the set audio threshold, an alarm should be generated. This alarm, for each designated cell location shall both annunciate at the intercom system masters as well as logged by the access control solution.
   6. Remote intercoms and multi-building security intercoms shall be interconnected as a complete system with network controller units, as required and shown on the plans.

D. System Operation
   1. Calls From Substation to Master Station
      a. A call request from a substation shall cause a corresponding green LED to flash and a tone to sound, on designated master(s). The LED shall continue to flash and the tone shall sound intermittently until accepted and answered at the master. Multiple call-in requests shall flash all the appropriate LED's. It shall be possible to have all substations call-in and flash their associated LED's until answered.
   2. Calls From Master to Substation
      a. A call may be initiated at a master station at any time by simply pressing the appropriate direct-select button. Operation shall be as described above. If the substation is already connected to a master, the second master shall receive a short busy tone and no connection is made.
   3. Parallel Calls To Multiple Masters
      a. It shall be possible to program calls from substations to annunciate simultaneously on multiple masters. When the call request is answered on one of the masters, immediate voice communication shall be established and the call shall be extinguished at all other masters. If a substation is already connected to one master, and a second master attempts to call that substation, the second master shall simply receive a short busy tone.

4. Audio Monitoring
   a. As standard, one of the feature buttons on the master shall function as a monitor button. Areas to be monitored (such as listening to elevators and parking areas) shall be selected and easily programmed by the user. When pressed, the red monitor LED on master shall illuminate and audio from all preselected stations shall be heard over master speaker. There shall be no tones, clicks, pops or noise transmitted to the substations monitored. Green LED's on the master, of all stations being monitored, shall illuminate steady. The monitor button shall be push on/push off.
5. Line Supervision
   a. As standard, one of the feature buttons on the master shall function as a manual fault indication switch. When pressed, the green LED's on master of all substations, with proper continuity of wiring pair, shall remain out. When fault indicating button is pressed, any station with a break or fault in wiring or has reversed polarity, shall be indicated by flashing the associated green LED on master.
6. Volume Control
   a. The master shall include two (2) incoming audio volume control buttons. Buttons shall be momentary, "press up," and "press Down." Buttons shall control volume by means of continuous digital control of the amplifier. Ordinary carbon type or wire round potentiometers, with exposed knobs, will not be acceptable.
7. Sound Detection
   a. System shall be capable of adding circuitry for automatic audio surveillance and sound detection in specific areas with intercom substations, such as cells. Each cell speaker shall receive a sound detection module as described below.

E. System Technical Requirements
1. Each master shall have a (5) watt master intercom amplifier, and a (24) watt substation amplifier, into 45 ohms. Frequency response shall be peaked for maximum voice articulation between 200 and 5000 Hz, + 3 dB. THD shall be less than 3 percent at full output, less than 0.5 percent at (1) watt. Amplifiers shall have balanced line outputs.
2. System shall require electrical power of less than (3) watts, at 24V 60 Hz, per substation.
3. System shall provide minimum of (1) watt of audio power per substation, expandable to (3) watts if required.

F. System Standard Features
1. System shall include the following basic features:
   a. Master-to-subs, press-to-talk, remote-reply communications.
   b. Easily expanded
   c. Programmable functions and add-on features
   d. Data connections to other devices or systems
   e. Call annunciation on masters from all substations (flashing LED & buzzer, or GUI)
   f. Direct-select push button on master for each substation
   g. Silent monitoring of selective substations (programmable)
   h. Manual test of substation wiring (opens and shorts)
   i. Master interface to multiple overhead paging zones

G. Equipment and Products
   1. Intercom Master Station
      a. Each master shall be microprocessor controlled with the appropriate number of electronic, direct-select, LED annunciated push button modules. Each push button module shall have (24) programmable push buttons for calling substations, P.A. paging zones, remote control functions, audio monitoring, etc. Each direct-select push button shall have (2) associated (LED) indicators, (green) for call-in annunciation and (red) for alarms. Push button shall include designation strips that are easily changed from the front. Shall include a Piezo electric buzzer for call-in tones.
      b. The master module shall include a 2" x 3" oval, 45 ohm, 1.5 watt speaker, an electret condenser microphone, volume up/down control buttons, a PTT press-to-talk button (with associated LED), (7) programmable feature/function buttons and (7) programmable master-to-master buttons (with associated Green LED's). Provide with handset, STENTOFON #9649.
      c. The master shall have a (50) pin amp connector for each (24) button module, screw terminals for 24V AC power input, and terminals for auxiliary tone, auxiliary speaker and system ground.
      d. The master module shall have its own (5) watt audio amplifier for individual control and adjustment. Amplifier shall provide balanced line output. Each (24) button module shall have its own (24) watt audio amplifier. It shall be possible to add (2) additional (24) watt audio amplifier boards to each button module to provide more audio power.
      e. The master shall provide circuitry for substation line supervision and fault indication.
      f. The master shall be mounted in metal housing suitable for desk top mounting. Housing shall be aluminum with black epoxy finish, trimmed in anodized aluminum. Shall include 8' flexible, 25 pair cable and 50 pin amp connector. Provide 24 button or 48 should the amount of intercom substations, cells speakers, or duress stations exceed 24.
      g. Provide as shown on the drawings. Provide a minimum of one (1).
   2. Power Supply
      a. Power supply shall provide 24V AC with a 150 watt (6) amp output. Shall include a power cable, grounded plug, and heavy duty steel case. Power supply shall be self limiting, and shall be (U.L.) listed. Shall be STENTOFON #1111. Provide as required.
   3. MDF Hardware
      a. Contractor shall include (1) standard (25) pair Telco cable with (50) pin amp connector and one (6) pin type punch down block for each (24) button master module. Twenty foot cable shall be STENTOFON #9658, blocks shall be STENTOFON #96570. Provide as required.
   4. Remote Control Unit
      a. Shall be a multipurpose relay control unit designed to provide remote control functions from the master station. Shall provide (2) relays with SPDT contacts, rated at 1 amp @ 24V AC/DC. First relay shall be wired in parallel with substation and pulls when substation is called. Second relay shall pull when activated by separate button on master. Shall be STENTOFON #9686. Provide as required.

5. Remote Control Board
   a. Shall be a multipurpose relay control unit designed to provide remote control functions and auxiliary contacts at the master station. Board shall include (24) relays with SPST contacts rated at 0.5 amps at 24V AC/DC. Relay shall be activated either by substation call-in or from substation buttons on master. Board shall mount inside master, and wire to each 24 button module. Shall be STENTOFON #9659. Provide as required.

2.39 INTEGRATED ELECTRONIC SECURITY SYSTEM

A. The IP Integrated Electronic Security System consists of the following subsystems. All systems referenced below shall be connected to a standalone security network.
   1. Access Control/Security Management System
   2. IP Closed Circuit Television System
   3. Network switches

B. Access Control/Security Management System
   1. System Description
      a. The Security Information Management System shall be a modular networked access control system. The access control system shall have the ability of handling facilities with multiple remote sites, controlled access with various reader technologies supported simultaneously, alarm monitoring, Photo Call-Up, Photo ID Badging, and CCTV integration that allows for easy expansion or modification of readers, inputs, and outputs. The system control at the central computer location shall be under a single software program control, shall provide full integration of all components, and shall be alterable at any time, depending upon the facility requirements. Reconfiguration shall be accomplished on-line through system programming, without hardware changes.
      b. The access control system must be able to support at least 10 simultaneous, fully functional, clients. The system will be used at a number of workstations for alarm display, programming and archival. The owner will designate which workstations will require to be a client.
      c. Provide a photo badging software module, graphical maps software module and image verification software module in the base bid. No exceptions will be allowed.
      d. The access control system shall be fully integrated to the CCTV system. Levels of the integration are specified below.
      e. The access control provider is responsible for providing all devices as shown on the drawings including but not limited to network switches, racks, readers, contacts, REX devices, control panels, power supplies, for a complete and operational system.
      f. The Security Workstation, as described below, will act as the primary workstation for all access control, alarm monitoring.
      g. The ACS shall support tight integration with IP video surveillance.
      h. The ACS shall be highly scalable and include provisions for future growth.
      i. The ACS shall support interlocking logic where noted doors cannot open unless other doors are closed. All doors within the sallyport shall be interlocked with one another.

j. Provide a software package which shall be a turnkey integration between the access control system and the video management platform which includes IP Cameras. The software shall operate without the need for revisions of either the access software or the video management software. The software integration shall operate on a access control workstation and/or separate computer. The software shall allow for automatic video switching where the following will occur; access control alarm events shall cause related camera video to 'pop up" over any application; a camera identifier shall be displayed; alarm related video shall be recorded on a local database, the alarm related video shall stop recording when an alarm is cleared, and alarm related video window shall have the ability to minimize when all alarms are cleared. The software shall also allow live control of PTZ type cameras.

k. Provide software training tutorial and movie, which shows the user how to navigate through the system without the need for tech support numbers. If systems do not have a training tutorial disc, provide a minimum of 24 hours of pre-recorded training. Provide in DVD format.

l. The system shall support both manual and automatic responses to alarms entering the system. Each alarm shall be capable of initiating a number of different actions, such as camera switching, activation of remote devices and door control.

m. Access control functions shall include, validation based on time of day, day of week, holiday scheduling, automatic or manual retrieval of cardholder photographs, and access validation based on positive verification of card, card/PIN, and PIN.

n. Utilizing assigned passwords, it shall be possible to define the levels of system operation for each individual Operator. Operator Actions range from basic monitoring to full control of the system databases.

o. The system programming shall be user-friendly Windows environment (use conventional "Title Bar", "Menu Bar", "Tool Bar" and "Status Bar") and allow mouse control of key functions. The programming shall be MENU driven and include on-line "Documentation", "Help" or "Tutorial" information, as well as on-line data entry examples. The software shall utilize combo boxes for all previously entered system-required data. The system shall provide supervised alarm point monitoring. Upon recognition of an alarm, the system shall be capable of displaying alarm information in text format, on a graphic floorplan, and switching CCTV cameras that are associated with the alarm point. The system shall be capable of arming or disarming alarm points both manually and automatically, by time of day, and day of week.

p. The method of communication from remote locations to the central components shall be transparent to the user.

q. After installation, the OWNER shall be able to perform hardware configuration changes as desired without the services of the MANUFACTURER.

r. Equipment repair shall be able to be accomplished on site, by module replacement, utilizing spare components.

s. All control components shall utilize "Distributed-Processing" concepts. The distributed processing shall include the ability to down-load operating parameters to any field panel, thus allowing the field panel to provide full operating functions independent of any other system component.

2. Additional Systems.

a. Photo ID Badging System.

1) Provide facilities for a complete photo ID Badging system, including: Integral Peripherals Flash Bus Video Capture Card; mega-pixel Camera with gooseneck; Ultra Magic Card RIO Printer; Printer Rolls.

b. Dual Monitor Output.

1) Provide a Dual Monitor output and a second Monitor, identical to the specified monitor.

c. Fault-Tolerant Server Computer using RAID-Level 5 shall be optionally available.
   1) Fault-Tolerant Server Computer using RAID-Level 5, minimum of 3 9 GB SCSII hot-swappable drives, dual and hot swappable power supplies, dual processors, error correcting memory.

3. Products
   a. The following manufacturers have been pre-approved for an Integrated Security system. Equals will be accepted as approved by Architect.
      1) Genetec
      2) S2
      3) Software House
      4) Hirsch.

4. System Configuration.
   a. The head-end shall support 1 Server Computer that may optionally be used as a full functioning Client. See Computer requirements section for quantities of computers.
   b. Host Computer to Controller Communication Protocols.
      1) Communications between the computer and the controller shall be accomplished by Scramble*Net Communications and shall be encrypted using a 64-bit cipher feedback method. The encryption shall be full time and not require any programming or key setting to operate.
      2) The system shall utilize RS232 up to 50' for hardwired applications.
      3) The system shall utilize RS485 up to 4000' (4-wire hardwired). Longer distances are allowed with a communications multiplexer / amplifier, if applicable.
      4) The system shall utilize TCP/IP for communicating over computer networks.
      5) All of the communications protocols shall be supported simultaneously on the system.
   c. Host Computer to Controller Communication Transmission Methods/Hardware.
      1) Communications between the computer and the controller shall be able to use any or all of the following methods:
         Fiber Optic.
         Ethernet.
   d. Proprietary Network Interface Hardware.
      1) The controller shall be interfaced to an industry standard personal computer running proprietary software with the addition of an opto-isolated network communications interface board. The Scramble Net Interface Board will accept RS232 or RS485 communications interface. Each board is uniquely addressable through on-board dipswitch settings and has an adjustable baud rate from 1200 – 19,200. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable.
   e. Maximum System Wide Capacities.
      1) The following shall be the maximum system wide capacities. The actual number shall be dependent upon the mix of controllers that make up the system. Only provide quantities as required.
         SIMULTANEOUS Workstations: 75
         Doors: 250
         Supervised Alarm Inputs: 1000
         Control Relays: 1000
         Controllers: 100
   f. Control Panel Specifications.
      1) The control panel shall incorporate microprocessor-based, digital technology, using high speed processing for maximum reliability.
   g. Distributed Intelligence.
      1) The system shall use distributed intelligence architecture, with controllers operating independently of one another.

2) Globalized functions for all controllers connected to an X-Box communications loop shall include: Use Count, Absentee Limit, Temporary Days, Passback, and Global I/O and shall not require the host to be online for processing and control.

h. Stand Alone Operation.
1) All database information required for standalone operation shall be stored at the control panel level. All decision-making shall be performed at the control panel, eliminating the need for degraded mode operation.
2) Proprietary software programs and control logic information used to coordinate and drive system hardware shall be stored in Flash Downloadable Read Only Memory.

5. Access Control Server
a. Provide a rack mounted server with the following specifications. Provide a UPS with battery backup for 10 minutes for each server.
1) Dual Core Intel Xeon E5620, 12 MB Cache, 1066 MHz max MEUM
2) Microsoft Windows 2008 Server Standard 64-bit.
3) 2GB RAM for solutions support 40 camera and under, 4 GB RAM for solutions supporting 40 and over.
4) 80 GB minimum of storage for the operating system, ACS applications, and Microsoft SQL Server 2008 Standard Edition.
5) Standard SVGA Video Card
6) 1280x1024 or higher screen resolution
7) 10/100/1000 Ethernet Network Interface Card
8) DVD ROM Drive
b. Provide Dell or equal.
c. Provide one (1).

6. System Software.
a. General layout of the software “Windows” will include but not be limited to:
1) Main Menu Bar shall be used to access all Functions from a standard pull down menu method.
2) Tool Bar ICONS shall be used to access all common Functions with a single mouse click.
3) Customizable Graphical User Interface shall allow for configuring the screens in a variety of layouts. Layouts for each window include: Docked to the Top, Bottom, Left, and Right; Floating; Child – Minimized, Maximized, Restored. Each Operator shall have their own unique layout for available options. If dual-monitors are used, the Customizable GUI shall apply to both monitors.
4) Tool Tips describing the feature(s) that the selected item represent, will be displayed in small “bubbles” underneath the selected item, field caption or other component. These tool tips shall be user definable.
5) Dialog Boxes will provide a means for entering information into fields and displaying information from the System Software database.
b. The Administration Console shall use the familiar Explorer metaphor with a tree of folders in the left pane and details of selected folders in the right pane. The left pane shall include the following main components: Main Administration Console, Software Configuration, Hardware Configuration, and Interface Configuration.
1) The Main Administration Console shall include:
Alarm Viewer.
Badge Designer.
Browser.
Customization Manager.
Enrollment Manager.
Event Viewer.
Graphics.

Report Manager.
Status Viewer.
SQL Manager.
Task Scheduler.

2) The Software Configuration Module shall include:
Credential Templates.
Time Zones.
Holidays.
Door Groups.
Function Groups.
Operations Groups.
Command Sets.
Workstations.

3) The Hardware Configuration Module shall contain:
Add either an S*NET or X*NET communications port, either serial or TCP/IP.
Add Hardware Controller.
Doors, Readers, Inputs, Outputs, Expansion Inputs, Expansion Outputs.

4) The Interface Configuration Module shall define the parameters for communicating to a CCTV switcher.

c. Workstation Customization.

1) The Operator may customize the general functionality of several features of the System Software per individual Operator. The features that may be customized will include but not be limited to: Alarm Viewer, Event Viewer, customizable Graphical User Interface.

2) Alarm Viewer will bring the “Alarm Viewer Window” forward on new alarm(s) while you are in other software windows.

d. Time Zones.

1) Time Zones define periods during which readers, cards, codes, alarm inputs, doors or other system features are active or inactive. Basic configuration parameters shall “ask” the Operator to define “when” the user is enabling (or disabling) a specific feature. In addition to Monday-Sunday, there shall be one day of the week called Holiday. When selected, there will be 4 Holiday Schedules that determine if the Holiday is to be followed for this Time Zone. There shall be 64 Standard Time Zones, 64 Master Time Zones, and 20 Grand Master Time Zones.

e. Holidays.

1) Holidays are used within the system for the purpose of defining if a Time Zone is to be followed on a defined Holiday. Each Time Zone has up to 4 Holiday schedules. There are 366 user definable Holidays this year and 366 days next year. It shall be possible for the Operator to “Make the rest of Today a Holiday”.

f. Door Groups.

1) Door Groups shall allow the user to establish groups of readers, each with its own unique Time Zone, at a facility for the purpose of granting or denying access to Credentials. Door Groups are assigned to Credential Templates, and people being added to the system take on the Door Group of the Credential Template selected during the enrollment process. A new Door Group may be defined when adding a Credential or Credential Template without having to exit and re-enter the Credential function for that Person.

2) The Door Group application shall allow the user to view any existing Door Group listed in the dialog box. A user, with proper authority, shall be able to modify, add, or delete a Door Group from the System Software.

g. Function Groups.
   1) Credentials can be assigned to perform a single User Function, like Momentary Access. When multiple User Functions are required by a Person, a Function Group may be defined and associated with one or more credentials. The Function Group requires a ScramblePad keypad to be used, where the Person's base Credential PIN number is entered, followed by an * (Asterick), followed by a one or two digit Extension digit, which defines which User Function will be issued for which Control Zone. This allows for a single person to perform multiple User Functions like: Unlock Door, Relock Door, Change Threat Level, Mask Alarm Inputs, Lock Down Doors.

h. Command Sets.
   1) A Command Set defines an action or actions to be sent to a controller or controllers. Command Sets can include: Unlock and Relock a Door; LockDown and Release a LockDown on one or more doors; make the rest of today a Holiday; Mask all Interior Alarm Points; change the facility Threat Level; Forgive All Passback. Once defined, a Command Set can be executed from the Command Set Window, or from a Graphic Floorplan ICON, if defined. There shall be an unlimited number of Command Sets available to be defined.

i. Operator Groups.
   1) Each Operator entered into the System Software system shall be assigned to an "Operator Group". This feature shall allow the Operator to take on the Rights to Components, Reports and Graphic Floorplans. The Rights for Components can grant or deny the ability to Add, Delete, Save, or Open a component, as well as restrict to the Properties or Dialog boxes to the Tabbed level.

j. Operator.
   1) Operators entered into the system shall take on the Rights of the Operator Group to which they are assigned. In addition, a unique set of Permissions can be defined per Operator which grant or deny the Operator's ability to perform system functions, like: Acknowledge and Clear 1 or more alarms; Assign/Unassign Credentials; Change Alarm and Event Viewer Properties; Display Scramble*Pad Codes; Download Credentials; Preview and Print Badges; Use any or all of the Component Windows.

k. Task Scheduler.
   1) There shall be a Task Scheduler that allows functions to be performed on an as needed basis, like activating and deactivating credentials. It can also schedule Tasks like Synchrozine Controller Clocks and Run Historical Log Archiver on a Daily, Weekly, Monthly basis.

l. SQL Database Manager.
   1) The SQL Database Manager shall be used to Backup and Restore data from the SQL database. Manual or automatic backups may be defined. SQL Scripts may also be run from the SQL Database Manager.

m. Diagnostic Window.
   1) There shall be a Diagnostic Window available to aid in system diagnostics / troubleshooting. Once a Controller is selected, the Standard Setup and Status diagnostic commands may be selected from a drop down list and sent to the selected controller. The response from the controller is displayed in the Diagnostic Window, and may be viewed, copied to the clipboard, a Report created and printed or saved to a file.
   2) In addition, any supported Hardware Command can be sent to the selected controller.

n. Status Viewer.
   1) There shall be a Status Viewer which displays in a spreadsheets type format, the real-time status of all or selected Doors, Readers, Inputs, Relays, Expansion Inputs, Expansion Relays. Devices may be grouped in to “Status Groups”, which are selectable from a drop down list. Devices may have selected information displayed. The available list includes the following:
      a) Name and Address.
      b) Status.
      c) Alarm and Acknowledge Status.
      d) Masking Status.
      e) Line Module Input Status and Type.
      f) Relay Status.
      g) Revision Number.
      h) Enabled Status.
      i) Controller Alarm Relay, Tamper and Battery Status.

o. Alarm Viewer.
   1) The Alarm Viewer shall have 4 panes: Alarm, Acknowledged Alarms, Instructions, and Comments. At the bottom of the Main Console display are counters to indicate Active Alarms, Acknowledged Alarms, and Off Normal Conditions. Double clicking the Counter will launch the Alarm Viewer. The Alarm Viewer may also be manually launched, or automatically in the event of a new alarm occurrence. Alarm Viewer properties that may be configured include:
      a) Require Acknowledgement Before Clearing.
      b) Auto Acknowledge on RTN (Return to Normal).
      c) Require Entry of Note on Acknowledgement..
      d) Force New Note on Multiple Acknowledgements.
      e) Require Entry of Note on Clear.
      f) Force New Note on Multiple Clear.
      g) Restore Alarm Viewer on New Alarm.
      h) Specify the number of Cached Alarms to Load at Launch of Alarm Viewer.
   2) Foreground, Background, Alarm, and Secure colors may be changed. In addition, the Columns of data viewed in the Alarm and Acknowledged windows may be selected and the sequence in which they will appear. The available columns include:
      a) ICN.
      b) Controller Time.
      c) Host Time.
      d) Description.
      e) Address.
      f) Level.
      g) Alarm ID.
      h) Acknowledge Time and Acknowledged By (available for the Acknowledged Pane).
   3) Tool bar ICONS shall include:
      a) Acknowledge Selected.
      b) Clear Selected.
      c) Acknowledge All.
      d) Clear All.
      e) Silence Beeper.
      f) Add Note.

4) Right Clicking an Alarm Event shall display a list of available options, including:
   a) Acknowledge.
   b) Clear.
   c) Acknowledge All.
   d) Clear All.
   e) Silence Beeper.
   f) Add Note.
   g) Go To Graphics.
   h) Display User Photo.

p. Event Planner.
   1) The Event Viewer can display all or Filtered Transactions. Custom filers may be defined and selected, or Standard selections can be made for main categories of Event types. Column width, order, selection, and scrolling direction are user definable, as well as text and background color.
   2) The number of cached events to load when launched, up to 10,000, may be defined. The Operator shall be able to scroll back in time to view events no longer seen on the screen, without the need for running a report.

q. Customization Manager.
   1) There shall be a Customization Manager that allows the Operator to define an alternate language or change the English name or label for each element of the software.
   2) Audio WAV files may be defined for playback when a particular Alarm Type is active.
   3) Priority Levels may be defined (1-99) for each Alarm Type.
   4) Operator Instructions per Alarm Type shall be user definable.

r. Report Manager.
   1) The Report Manager shall allow the Operator to select from a number of pre-defined Reports. Custom Reports can be created outside the software, and added to a Custom folder, making the Custom Reports available from within the Report Manager application.
   2) Once a Report is selected, the default Criteria and Sorting options may be used, or custom Criteria and Sorting options may be selected.
   3) Once the report is run, it may be viewed, printed, or saved in various standard file formats.

s. Standard Reports included as standard shall include:
   1) Customization Reports.
      a) Component Resources.
      b) Customizations Report.
   2) Hardware Configuration.
      a) Controllers.
      b) Doors.
      c) Expansion Inputs.
      d) Expansion Relays.
      e) Inputs.
      f) Network Layout.
      g) Printers.
      h) Readers.
      i) Relays.
   3) History Log.
      a) Active Alarms by Date.
      b) Alarm Log by Date.
      c) Alarm Log by Date with Comments.
      d) All Events Log.
      e) External Events Log.

f) Internal Events Log.
g) Operator Log.
h) User Activity Log.

4) Person Information.
a) Credential Status.
b) Door Access by Person.
c) Dossier Style by Person.
d) Expired and To-Be-Expired Person Access.
e) Expired Credentials.
f) Last Access by Person.
g) Person Access and Function Group Summary.
h) Person Access and Function Group Summary with Codes and Cards.
i) Person Access by Door.
j) Person Access Summary.
k) Person Access Summary with Codes and Cards.
l) Person FG Summary with Codes and Cards.
m) Person Function Group Summary.

5) Software Configuration.
a) Command Sets.
b) Door Groups.
c) Function Group Extensions.
d) Functions Groups with Users.
e) Functions with Users.
f) Holiday Schedules.
g) Holidays.
h) Operator Groups.
i) Operator Groups.
j) Operators.
k) Time Zones – Grand Master Time Zone.
l) Time Zones – Master Time Zone.
m) Time Zones – Standard Time Zone.
n) Time Zones – Standard Time Zones in Use.

t. CCTV Interface.

1) From the NVR Interface Configuration, the Operator shall be able to Search and Retrieve video from one or more cameras for a specified period of time. In addition, the Event Viewer History enables a qualified Operator to track and report events that are specific to the NVR subsystem history logs. These logs include:
a) Active Alarms by Date.
b) Active Alarms by Date with Comments.
c) Alarm Log by Date.
d) Alarm Log by Date with Comments.
e) All Events Log by Category.
f) All Events Log by Date.

2) The NVR interface shall allow a qualified Operator to:
a) View Cameras.
b) Generate a Host Alarm.
c) Stop a Host Alarm.
d) Get Alarm List from NVR.
e) Search and Retrieve Recorded Video.
f) Play Local Video.
g) Time Synchronization.
h) Diagnostics.
i) View NVR Properties.

3) When Viewing cameras, the Operator may select Small, Medium, or Large display size, and select for viewing 1, 4, 9, or 16 cameras to display in the View Window. Cameras may be selected then dragged to the window the Operator wishes to view the camera in. If the camera has Pan/Tilt/Zoom/Focus/Iris control, the Operator can open the control functions and operate the on-screen controls for the selected camera.
4) An Operator shall be able to define Triggers and Actions that allows Alarms and Events in Velocity to cause Alarm recording in the NVR through an API interface.
5) In Graphics, NVR Cameras and NVR recorder ICONS can be placed on floorplans and used to view the associated video from the selected camera.
6) There shall be an application that lets a qualified Operator to view multiple cameras from multiple NVRs in a single window. Cameras can be displayed in 1, 4, 9, or 16 display views and these views can be saved as View Groups for fast and easy selection by the Operator.

u. Console Preferences.
1) The Console Preferences shall define specific settings or devices for use with the software. These shall include: File Paths; Fonts to use in the Alarm and Event Viewers; Show Splash Screen on Startup; Access and Enable Customized Values for Components in Customization Manager; Use 24-Hour Time Format; SQL Server and Network Connections settings; Enrollment Station properties; Report, Badging, and Alarm/Event Printer properties; CCTV Properties.

v. Hardware Configuration.
1) This function shall contain the required definition of the hardware components of the system. The database files shall be based on the hierarchy of the system hardware as it is physically installed in the field.

w. Controller Properties.
1) Controller Properties shall define all General settings for the Controller. These setting will include: Name, Type, Address, Local Time Zone, Enabled Status, Firmware Revision Number and Date, Expansion Option Boards Installed and available Hardware. All additional Controller Setup Options can be defined here and are detailed in the Firmware Features section below.

x. Controller Device Properties.
1) The Controller Device Properties shall define all connected field devices, including: Doors, Readers, Inputs, Relays, Expansion Inputs, and Expansion Relays. Device names and all operating parameters shall be definable if operation other than the included defaults is required.

y. Graphics.
1) The Graphics application shall allow the Operator to add, delete or modify graphic floorplans and add indicator icons to graphic floorplans that represent Controllers, input/output points, readers, or cameras located in the facility.
2) There shall be two Modes, Live and Design. The Live mode shall be used for real time monitoring. In addition, right clicking an ICON presents the Operator with a list of available Access or Control Functions that can be issued to the device. The Design mode allows the Operator to Define which Graphics are to be used, place ICONS on the Graphics, and define properties for each ICON.
3) There shall be a Bird’s Eye Viewer that provides a key plan that can be panned and scrolled by moving the red box, which indicates the current viewing area.
4) There shall be a Directory of available Graphics to easily select the desired Graphic to display.

5) The Graphics application shall display the real-time state and condition of Alarm Points and Doors. The Door ICONS shall enlarge and change from a closed door ICON to an Open door ICON, representing that the door is open. When the door is closed, a closed ICON will appear again. The Alarm ICONS shall enlarge and change from a closed contact ICON to an Open contact ICON, representing that the alarm device is active. When the Alarm Device is restored to its normal condition, a closed contact ICON will appear again. The ICON will also display the Device Name and Alarm Condition that caused it to go into an Alarm condition. The Color of the ICON will also change based on whether it is in alarm or secure.

z. Badge and Graphics Designer.

1) The Badge and Graphics Designer shall allow the Operator to create and customize an unlimited number of Badge Templates that may be assigned to a Person in the Enrollment Manager and create Backdrops to be used in the Graphics module.

2) An Object Toolbar shall be available for selecting Objects to appear on the Badge Template or Backdrop, including: Bit Map Logos, Photos, Fixed Text, and Database Fields. Each Object shall have a Properties box where the specific Properties of that Object are defined, including: File, database field, Font color, Font Style, Font Size.

aa. Enrollment Manager.

1) The Enrollment Manager application shall maintain information related to a Person, and Credentials assigned to that person. Multiple Credentials per person shall be supported. The list of People shall be able to have Custom filters applied, allowing for quick and easy grouping of desired people. There shall be a quick find option for finding a specific person or credential.

2) The Personal Information pane shall include the General and Additional User Defined fields. The system shall be capable of defining up to 36 user definable fields of information per Person. These field names can be either a “Text Box”, “Dropdown” where the Operator can enter text, or select from a Dropdown List, or a “Dropdown List” where selecting from the List is required. A Photo field shall be available for acquiring a live video image, acquire an image from a TWAIN device, or acquiring a photo from an existing file. A Record Last Updated field shall be available, as well as Preview and Print a Badge. A signature field shall also be available.

3) Once a person is added, one or more Credentials may be added to that Person. Credentials may be added using a Credential Template, or directly without a Credential Template. The Credential will take on the properties of the Credential Template if used. There shall be a Card Enrollment Station used for entering card data into the system. PIN Numbers can either be randomly selected, or Operator/User selected.

4) Once a Person is selected from the List, the Credential Status and information is displayed for the assigned Credentials. The information includes: IDF, ID, Function, Description, Status, Expires On, Last Access, Last Door, Tag, and Alert. An Operator may right click on a Credential, and will be presented with the following options: Tag, Alert, Disable, Forgive Passback, Override Code Tamper, Reset Limit Count, Force Download, Unassign, Delete, and Properties.

5) The bottom of the Enrollment Manager window shall display counters for: People, Assigned Credentials, Unassigned Credentials, and Guest Credentials.

7. Network Switch

a. Provide an independent network switch as specified elsewhere in this specification. Connect all access control panels, workstations and the server to the switch for a complete and operational network solution.

8. Access Control Panel
   a. The access control panel shall have the specified features detailed in the following sections.
   b. Controller Board.
      1) The controller board shall be microprocessor based, incorporating Flash ROM (firmware) downloadable from the Host Computer, RAM (User Information, System Setups, Event Transaction Buffer) and a Clock/Calendar. The ROM shall be modularly upgradeable in the field for enhancements to system features. All powered connections to the controller board shall be protected by fuses. All wiring connections to the controller board shall be to "Phoenix" type screw terminals. Each door connection shall consist of terminals for two readers, one 10 Amp rated Form C dry output relay for lock control, and one input for monitoring a status switch, a request-to-exit device, and a tamper switch. There shall be status indicator lights for active relays, as well as diagnostic indicator lights to aid in system troubleshooting. There shall be dedicated alarm output relay/s for external reporting of the following conditions: Alarm; Duress; Tamper; and Trouble.
   c. Enclosure.
      1) The controller enclosure shall be a NEMA style metal cabinet designed for surface mounting. It shall have a tampered, removable hinged door with a high security key lock. It shall have conduit knockouts to allow from 1/2" to 1" EMT conduit to be used for wire entry into the cabinet.
   d. Internal Power Supply.
      1) The controller shall have an internal power supply that will accept 50 Hz/ 200 - 240 VAC, or 60 Hz/100 - 120 VAC. The primary side of the power supply shall be protected with a fuse. The power supply shall provide 28 VDC power to the controller board, internal battery charger, selected card readers, and reader interface boards.
   e. Standby Battery.
      1) The controller shall have an internal standby battery that is capable of running the system during AC power interruptions. It shall be recharged by a charging circuit incorporated into the controller board.
   f. Expansion Options.
      1) A maximum of 5 expansion boards can be installed in the controller. A SNIB Board is included with each controller and takes up one of the available expansion slots.
   g. Alarm Inputs.
      1) The controller shall be capable of accepting up to 32 additional supervised alarm inputs, in increments of 8. The alarm expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. Provide a minimum of 2 boards per door controller.
      2) The sensitivity of the line supervision shall be 2% AA Line Monitoring.
   h. Relay Outputs.
      1) The controller shall accept up to a maximum of 24 additional Form C, 2 Amp rated relay outputs in increments of 8. The relay expansion boards shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. Provide a minimum of 2 relay boards per door controller.
   i. CODE/Buffer.
      1) The controller shall be capable of expanding the CODE database up to a maximum of 132,000 Users with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable. Expansion Board shall expand the Buffer capacity as well as the Code record capacity.

j. Event Transaction Buffer.
   1) The controller shall be capable of expanding the event transaction buffer up to a maximum of 20,000 events and 2,000 alarms with the addition of a memory expansion board. The board shall be mounted in the controller cabinet and connect to the controller board via an expansion bus cable.

k. Intelligent Reader Interface.
   1) The control panels shall utilize an intelligent reader interface to communicate with card readers of various types. The interface shall be microprocessor based and allow data formats including ABA magnetic stripe, Wiegand (26 to 55 bit), Proximity, Bar Code, Touch Memory, Barium Ferrite, RF and Biometric. The interface shall utilize a digitizing algorithm, which will convert the card data to a unique number, thus, eliminating the need for facility codes. A single interface shall support both entrance and exit readers with keypads associated with each door. The interface shall be U.L. Listed to U.L.294. Provide a Intelligent reader interface for every reader.

l. Provide Hirsch M series access control panels or equal.

9. Access Control Firmware
   a. General Features.
      1) The software for the controller shall reside in Flash ROM (firmware) and be located on a plug removable module on the controller board to facilitate easy field upgradability of the features. All of the necessary software for a fully functional System is located in the controller. The controller firmware shall include the following general features at a minimum and be fully supported by the software head-end.
         a) 3 - 15 digit keypad Code's.
         b) Duress digit for keypad Code's.
         c) 150 Time Zones for access restriction and automatic event control.
         d) 128 Access Zones for access management.
         e) 256 Control Zones for alarm and relay management.
         f) 366 programmable holidays this year, 366 days next year. Each Holiday may be assigned to 1 – 4 Holiday Schedules.
         g) Automatic daylight savings time clock adjustment.
         h) 27 different functions for Code's and cards, e.g. access, unlock, re-lock, alarm mask, relay control.
         i) Add user records.
         j) Tag users for annunciation at host computer.
         k) 4,000 Users.
         l) 750 event, 750 alarm transaction buffer.
   b. Access Control Features.
      1) The controller shall include the following access control features at a minimum.
         a) Restrict access by: time of day; day of week; door; holiday.
         b) Momentary Access of door up to 8100 seconds.
         c) Extended Access for User Definable Momentary Access duration (requires ScramblePad). ScramblePad will display time remaining on the minute, and annunciate at the defined "Warning Time".
         d) Special Needs Time Extension to provide additional time for Momentary Access and Door Open Too Long for selected people.
         e) Unlock/Re-lock of door by CODE, card or Time Zone.
         f) Door status monitoring shall allow for: door forced monitoring; door-open-too-long monitoring; door-open-too-long while door is unlocked; auto-re-lock of door when opened or closed.
         g) Request-to-exit masks alarm and/or unlocks door.

h) 2 person requirement by door. A user can be defined as Normal, A/B Rule A, A/B Rule B, Executive Override. Can be disabled by Time Zone.
i) 63 Passback Zones. Can be disabled by Time Zone. A User can designated with Passback Executive Override.
j) Use Count limits on users.
k) Absentee Rule limits on users.
l) Temporary Day limits on users.
m) Occupancy Counting / Minimum & Maximum limits per Passback Zone.
n) Deadman CODE / Timer.
o) Threat Levels – 99 Levels may be defined. Based on the Level in effect for the facility, selected readers may be disabled, dual readers in Card/Code Only During Time Zone can require dual, and selected User's Credentials can be disabled.

c. Alarm Management Features.
1) The controller shall include the following alarm management features at a minimum.
a) Momentarily mask alarm by CODE and/or card.
b) Mask/unmask alarm by CODE and/or card or by Time Zone.
c) Alarm device supervised while masked.
d) Tamper switch on alarm device monitored while masked.
e) Tamper Input may be configured to operate as a "Latch Monitor" with the appropriate door lock hardware.
f) Entry/Exit delay per alarm input.
g) Alarm input triggers relay/s.

d. Relay Control Features.
1) The controller shall include the following relay control features at a minimum.
a) CODE and/or card, input, or other relay triggers relay/s.
b) Trigger relay/s by time zone.
c) Relay may be normally de-energized or energized.
d) Disable relay/s during time zone.
e) Clear relay at end of time zone

10. Card Reader/Key Pads Interfaces.
a. Readers.
1) The controllers shall accept all of the following reader technologies concurrently: Mag Stripe; Wiegand; Proximity; Bar Code; Barium Ferrite; Biometrics - Retinal Scan, Hand Geometry, Fingerprint; Radio Frequency. The readers can be used for access control, alarm management, and/or relay control and shall be capable of being used alone (keypad only, card only) or a scrambling keypad and any other reader technology may be combined to operate as a dual technology reader where two valid IDs (PIN and card) are required.

b. Proximity Card Readers.
1) The controller shall be capable of using proximity readers that output a standard 26-55 Bit Wiegand data format. The readers can have a short or long read range and be unidirectional or bi-directional.

c. Miscellaneous Readers.
1) The controller shall be capable of using any reader technology that outputs a standard ABA/ISO data format or a standard 26-55 Bit Wiegand data format. Readers that meet this requirement include: Radio Frequency; Biometrics - Hand Geometry, Retinal Scan, Finger Print, Voice Recognition; Smart Card; and Barium Ferrite.

11. Fiber Optic Transceivers
    a. Provide multi-mode Fiber optic transceivers as required for the system. Provide step down transformers as required.
12. Hardware compatibility list (HCL)
    a. The access control system (ACS) shall interface with IP-enabled hardware access controllers, interface modules, and IO modules.
    b. The ACS shall have an open architecture that supports the integration of third party IP-based door controllers. Through these door controllers, the ACS shall interface with industry standard access control readers.
    c. The ACS shall have an open architecture that supports the integration of third party IP-based IO hardware modules. Through IO modules, the ACS shall interface with multiple input points and connect to multiple output relays.
    d. The ACS shall simultaneously support mixed configurations of access control hardware from multiple vendors.
    e. The ACS shall support multiple types of hardware devices:
        1) Single-reader controllers
        2) 2-reader controllers
        3) 1- to 64-reader controllers
        4) Integrated readers and door controllers
        5) Power-over-Ethernet (PoE) enabled door controllers
    f. The ACS shall support multiple hardware configurations:
        1) IP edge devices (door controllers and IO modules)
        2) Multidrop configuration using the RS-485 configuration protocol
    g. The ACS shall support the following IP-enabled controllers.
        1) Specialty Sensors Technologies Inc.
        2) HID Corporation
    h. The ACS shall not support HID hardware units in the online mode of operation.
    i. The ACS shall support most industry standard card readers that output card data using the Wiegand protocol.
    j. The ACS shall support HID Clock-and-Data readers.
    k. The following USB enrollment readers shall be supported:
        1) RF Ideas pcProx HID USB reader for enrolling proximity cards
        2) RF Ideas AIR ID Enroll iCLASS ID# USB reader for enrolling HID iCLASS cards
        3) RF Ideas AIR ID Enroll 14443/15693 CSN USB reader for enrolling a MIFARE card using the CSN (card serial number)
13. Control Panels
    a. General
        1) The control panels include but no limited to card reader modules, input modules, output modules, power supply, harnesses, and batteries. Provide quantities as required for a complete working system. Each module card shall be neatly installed in a locked wall cabinet. Enclosures shall be located in MDF or as shown on the drawings. Each controller shall be connected to the security network switch. Provide Hoffman enclosures or equal.
    b. Features
        1) Stores a complete access control and configuration database for up to 32 Reader Interfaces (up to 64 doors) and 44,000 cardholders with expansion capability up to 250,000 cardholders.
        2) The access control system interfaces with combinations of devices with a maximum of: 32 Door/Reader interfaces (up to 64 doors/readers) or 32 input monitor interfaces 9 (up to 512 monitor points) or 32 output control interfaces (up to 384 control relays)
        3) Reports supervised inputs/alarms with 255 priorities.
        4) Includes an HTTP API, Windows® DLL API, and direct communication API.

5) Allows local connection of a laptop computer for diagnostics and configuration.
6) Connects to the host and other devices on a TCP/IP network.
7) Receives and processes real time commands from the host software application.
8) Reports all activity to the host.
9) Controls and communicates with all connected devices.
10) Buffers offline transactions and uploads to the host when communication is restored.
11) UL 294 and UL 1076 recognized component.

c. Provide HID VertX series or equal.

14. Combination Card Reader and Keypad
    a. Provide contactless smart card readers with keypad as shown on the drawings.
    b. Each reader shall operate on a 13.56 transmit frequency.
    c. The reader shall have a Weigand output.
    d. The readers shall have both an audio and visual notification for access granted and access denied.
    e. The reader shall be suitable for indoor and outdoor applications.
    f. The reader shall operate up to 500ft on 22AWG cable.
    g. The reader shall be able to communicate with either 2K, 16K or 32K bit iClass cards.
    h. Provide HID RK40 iClass readers or equal.
15. Card Readers
    a. Provide contactless smart card readers as shown on the drawings.
    b. Each reader shall operate on a 13.56 transmit frequency.
    c. The reader shall have a Weigand output.
    d. The readers shall have both an audio and visual notification for access granted and access denied.
    e. The reader shall be suitable for indoor and outdoor applications.
        1) The reader shall operate up to 500ft on 22AWG cable.
    f. The reader shall be able to communicate with either 2K, 16K or 32K bit iClass cards.
    g. Provide HID R40 iClass readers or equal.
16. Contactless Smart Key Fob
    a. The smart key shall be 13.56MHZ and shall be an iClass key manufactured by HID Corporation or equal.
    b. The key shall be a 2000 bit card with two application areas. One shall be for access control and the other for user customization.
    c. The smart key shall have an operating temperature of -40 to 158 degrees Fahrenheit, and shall have an operating humidity of 5-95% noncondensing.
    d. The card shall meet ISO 15693 standards for contactless communications.
    e. ProvideHID iClass Key model 2050 or equal.
    f. Provide 200 key FOBS.
17. Door Contacts
    a. Furnish and install 3/4” recessed magnetic door contacts as shown on the drawings.
    b. Provide GE 1078C or equal.
18. Overhead Door Contacts
    a. Furnish and install overhead door contacts as shown on the drawings. Each contact shall be wired to a separate input point on the ACS.
    b. Overhead doors and pedestrian doors within the sallyport shall be interlocked with one another.
    c. Provide GE 2200 series or equal.

19. Request-to-exit devices
    a. Furnish and install motion request-to-exit sensors as shown on the drawings and as required. Devices shall mount directly above the each door. Utilize doors that have hardware which have integral request-to-exit switches as required. Coordinate with door hardware.
    b. Provide DS 150i or equal with trim plate.
20. Auxiliary Power Supply
    a. Provide an auxiliary power supply for REX sensors, duress beacon, duress sounders, etc as required. Provide Altronix or equal.
21. Electric strike/magnetic locks power supply
    a. Furnish and install electric strikes and magnetic locks power supplies as needed and required.
    b. 8 or 16 outputs, individually programmable for: Fail safe, Fail secure, Form "C' relay contact, Constant voltage for auxiliary devices, Fire Alarm Interface (FAI), Negative or open collector trip, Positive trip, Isolated trip.
    c. Each output shall be fuse protected.
    d. Provide coordination with door hardware contractor on proper current draws.
    e. Power supplies shall be interfaced to the fire alarm system as required.
    f. Power supply shall be UL Listed.
    g. Provide Altronix AL series or equal.
22. Locking Devices (Electric strike/Magnetic locks/Electric locks/Electric Hinges)
    a. Furnished and installed by others, wired by IESS Sub-Sub Contractor.
23. Beacons
    a. Provide blue duress security beacons as shown on the drawings. The unit shall wall or ceilings mount. The unit shall be 12/24 VDC and wired to the security management system.
24. Duress Stations
    a. Provide remote duress red mushroom push button as shown on the drawings. The device shall be designed for high security applications and shall be vandal proof. Each duress button shall be wired to the security system for camera call-up and general alarm conditions. Each button shall report and be programmed independently of one another.
    b. Provide Rauland HSS8 or equal.
25. Security Sounder
    a. Provide a security sounder as shown on the security drawings. The sounder shall be wired back to the closest access control panel and be programmed per the customer’s requirements. The sounder shall be activated upon activation of the duress buttons.
    b. System Functionality
26. Operation Modes
    a. The ACS shall support online, mixed mode, and offline modes of operation.
    b. In the online mode, the ACS software shall make all access decisions in real-time. Requests from the hardware controllers and responses from the Access Server shall be sent over the IP network. This shall only be supported with controllers that are capable of functioning in the online mode of operation.
    c. In the mixed mode of operation, the hardware controller shall make all access decisions and dynamically report activity to the ACS in real-time.
    d. In the offline mode, the hardware controllers shall function as stand-alone units. The ACS shall revert to the offline mode when the hardware controller is unable to communicate with the ACS. In this mode, the controllers shall manage all access requests and shall keep a log of access activity. Access decisions shall be based on information stored in the controller. When communication is re-established, the activity logs are uploaded to the ACS.

27. Controller (Unit) Management
    a. The ACS shall support the discovery, configuration, and management of IP enabled controllers and IO modules (hardware units). A user shall be permitted to add, delete, or modify a controller if he has the appropriate privileges.
    b. The ACS shall support the configuration of units from the Configuration UI.
    c. The ACS shall support automatic unit discovery. The user shall set the settings for discovery ports and types of unit discovery and the ACS shall automatically detect all connected devices.
    d. The ACS shall support remote firmware upgrades, if supported by the hardware. Upgrades shall be executed on edge devices connected to the network.
    e. The ACS shall support multiple reader types, including card or keypad readers. It shall be possible to define controller settings on a controller-by-controller basis. This shall permit full customization of the access control infrastructure by customizing controller settings based on card and reader specifications.
    f. Inputs detected by the controller or IO modules shall trigger appropriate events in the ACS.
    g. IO module inputs and outputs shall support both user-defined and physical names. It shall be possible to modify user-defined names.
    h. Where supported by the hardware controllers, the ACS shall send grant access or deny access commands to the controller (online mode). Commands to lock or unlock a door shall be based on a request from a cardholder or on a predetermined unlocking schedule (or an exception to an unlocking schedule).
    i. Maintenance mode
        1) The ACS shall support Maintenance Mode operation during controller installation or maintenance.
        2) While in maintenance mode, the ACS shall force a door to be unlocked (lock schedules are overridden).
    j. Unit Swap Utility
        1) The ACS shall support a unit swap utility to swap out an existing controller with a new controller.
        2) The unit swap utility shall avoid the reprogramming of the system whenever a unit is replaced.
        3) All logs and events from the old unit are maintained.
28. User and User Group Management
    a. The ACS shall support the configuration and management of users and user groups. A user shall be able to add, delete, or modify a user or user group if he has the appropriate privileges.
    b. Common access rights and privileges shared by multiple users shall be defined as User Groups. Individual group members shall inherit the rights and privileges from their parent user groups. User group nesting shall be allowed.
29. Cardholder and Cardholder Group Management
    a. The ACS shall support the configuration and management of cardholders and cardholder groups. A user shall be able to add, delete, or modify a cardholder or cardholder group if he has the appropriate privileges.
    b. The ACS shall permit the following activation/expiration options for a cardholder's profile:
        1) Delayed activation of a cardholder's profile
        2) Expiration based on the date of first use of credential
        3) Expiration on a user-defined date
    c. It shall be possible to associate a picture to the cardholder's profile. The picture shall be imported from a file, captured with a digital camera, or captured from a video surveillance camera. When a cardholder event occurs, the picture of the cardholder shall be displayed in the Surveillance UI. The ACS shall support multiple standard picture formats.

d. It shall be possible to create a cardholder without requiring the immediate assignment of a credential. Credential assignment can occur at a later time.
e. Cardholder groups shall enable the grouping of cardholders to facilitate mass changes to system settings. It shall be possible to assign cardholder groups to access rules, thus avoiding the assignment of one cardholder at a time.

30. Credential Management
    a. The ACS shall support the configuration and management of credentials, e.g. access cards and keypad PIN numbers. A user shall be able to add, delete, or modify a credential if he has the appropriate privileges.
    b. User shall be able to add Custom Fields (user-defined fields) to credentials. Creating a new credential shall be accomplished either manually or automatically.
    c. Automatic creation shall allow the user to create a credential entity by presenting a credential to a selected reader. The ACS shall read the card data and associate it to the credential entity. It shall be possible to automatically enroll any card format (128 bits or less).
    d. Manual creation shall allow the user to select the type of credential to create and to enter the data manually. The user shall be able to create the following credential types:
        1) HID H10301 Standard 26-bit card format (facility code and card ID)
        2) HID H10302 37-bit format (no facility code)
        3) HID H10304 37-bit format (facility code and card ID)
        4) HID H10306 34-bit format (facility code and card ID)
        5) HID Corporate 1000 35-bit format
        6) Keypad PIN.
    e. The ACS shall permit the creation of one or more credentials in advance, without requiring the assignment of the credential(s) to a cardholder. A credential in this state shall be designated as an “unassigned credential”.
    f. The ACS shall support multiple credentials per cardholder, without necessitating duplicate cardholder information. The ACS shall automatically detect and prevent attempts to register an already-registered credential.
31. Badge Designer
    a. The ACS shall be capable of the design and implementation of badges that define the content and presentation format of a badge.
    b. It shall be possible to set the border thickness, border color, and fill color of badge objects (content).
    c. Dual-sided badges shall be supported.
    d. A badge template import and export function is available as an additional option to allow the sharing of badge templates.
32. Door Management
    a. The ACS shall support the configuration and management of doors. A user shall be able to add, delete, or modify a door if he has the appropriate privileges.
    b. The ACS shall permit multiple access rules to be associated to a door.
    c. The ACS shall support the following forms of authentication:
        1) Card Only
        2) Card or Keypad (PIN)
        3) Card and Keypad (PIN)
    d. It shall be possible to define a schedule for when Card Only or Card and Keypad authentication modes shall be required.
    e. Extended Grant Time
        1) It shall be possible to set an extended grant time on a per-door basis (in addition to the standard grant time).
        2) Cardholder properties shall include the option of using the extended grant time.

3) When flagged cardholders are granted access, the door shall be unlocked for the duration of the extended grant time instead of the standard grant time.

f. Readerless door
1) The ACS shall support doors configured solely with a lock, a REX, and a door contact but without readers.
2) Implementation of a readerless door shall be possible with the use of standard access hardware IO modules. External hardware such as timers shall not be required.
3) Unlocking schedules shall be programmable for readerless doors.
4) Standard door activity reports shall also be possible with readerless doors.

g. Unlocking schedules and exceptions to unlocking schedules shall be associated to a door. An unlocking schedule shall determine when a door should be automatically unlocked. The ACS shall also support the use of a specific offline unlocking schedule. Exceptions to unlocking schedules shall be used to define time periods during which unlocking schedules shall not be applied, e.g. during statutory holidays.

h. Walkthrough Mode for reader enrollment
1) The Walkthrough Mode shall include an installation wizard. The wizard shall allow the user to detect, enroll, and associate newly installed access control equipment with doors.
2) The Walkthrough Mode shall permit a cardholder to walk to each new access read point (card reader) and trigger and access control request. The ACS shall log all access requests and readings made during the walkthrough exercise. Once all the access control equipment is detected, the installation wizard shall allow the user to associate the equipment to the door as well as set the hardware association settings (door lock, REX, manual station, door sensor).
3) The Walkthrough wizard shall validate whether there are potential assignment conflicts and notify the user.
4) The ACS shall support the Walkthrough Mode in real-time, report, and mixed mode of operation. Real-time mode shall allow the immediate enrollment of doors. Report mode shall allow the discovered access read points to be stored in a report for enrollment at a later time. The user shall be able to specify a start time and an end time for the walkthrough when in report or mixed mode.

33. Area Management
a. The ACS shall support the configuration and management of areas. A user shall be able to add, delete, or modify an area if he has the appropriate privileges.
b. The ACS shall support areas within areas (nested areas).
c. The ACS shall permit multiple access rules to be associated to an area. To facilitate the assignment of access rules, the ACS shall support associating rules to areas in lieu of doors. All perimeter doors shall then inherit the access rules assigned to the area
d. Antipassback
1) The ACS shall support antipassback functionality. When a passback situation is detected, an associated antipassback event shall be triggered in the ACS.
2) The ACS shall support the following types of responses to passback events:
3) Soft mode (event is logged only)
4) Hard mode (event logged and cardholder denied access)
5) Area activity reports shall also include antipassback events.
6) An exempt functionality shall be available to exempt certain cardholders (e.g. VIPs) from the antipassback rules.

7) Operator shall be able to forgive (grant a free pass) an antipassback violation for a cardholder.
8) Operator shall be able to forgive (grant a free pass) an antipassback violation for a cardholder group.

e. Interlock, Lockdown, and Override
1) It shall be possible to create an area interlock consisting of two or more doors. When enabled, the interlock shall ensure that only a single door can remain open at any point in time; once a door is open, all other doors that are part of the interlock are prevented from opening.
2) Interlock shall allow users to create scenarios such as mantraps, controlled lab environments, and white rooms with the simple click of a button.
3) The interlock functionality shall support doors with or without readers (readerless doors).
4) Interlock shall be supported with standard access control IO modules. Programmable logic controllers (PLCs) shall not be required.
5) Lockdown and override functions shall be available with the interlock.
6) Lockdown. A hardware input such as a switch or relay shall be used to prevent all access to the interlocked area.
7) Override shall be possible. The interlock can be overridden and the doors will function as in any standard installation.
8) Area activity reports shall include events associated to interlock and lockdown.

34. Zone Management
a. The ACS shall support the configuration and management of zones for input point monitoring. A user shall be able to add, delete, or modify a zone if he has the appropriate privileges.
b. A zone shall monitor the status of one or more inputs points. Zone monitoring or input point monitoring shall be possible through the use of a controller and one or more input modules. A single controller shall supervise up to 512 inputs.

35. Input/Output (IO) Linking
a. Zone management shall support Input/Output (IO) Linking. IO linking shall allow one or more inputs to trigger one or more outputs.
b. IO linking shall be available in offline mode when communication between the server and hardware is not available.

36. Schedule Management
a. The ACS shall support the configuration and management of schedules. A user shall be able to add, delete, or modify a schedule if he has the appropriate privileges.
b. Schedules with the “Specific” period type shall enable the user to set schedules for multiple specific days of the year. Starting from the days of the year selected, the user shall be able to define schedules for the previous day, current day, and day after.

37. Access Rule Management
a. The ACS shall support the configuration and management of access rules. A user shall be able to add, delete, or modify an access rule if he has the appropriate privileges.
b. An access rule shall be associated to a door side (entry or exit reader), door (both entry and readers), area, or elevator floor. It shall be possible to create and unlimited number of access rules per door, area, or elevator floor.

38. Event/Action Management
a. The ACS shall support the configuration and management of events. A user shall be able to add, delete, or modify an action to an event if he has the appropriate privileges.
b. The ACS shall receive all incoming events in the system. The ACS shall take the appropriate actions based on user-define event/action relationships.

c. The ACS shall be able to import events from multiple video systems.
d. The ACS shall support IO linking; one or more inputs shall trigger one or more outputs.
e. The ACS shall allow the creation of custom events.
f. The ACS shall have the capability to execute an action in response to an event.
g. The ACS shall allow a schedule to be associated with an action. The action shall be executed only if it is an appropriate action for the current time period.

39. Alarm Management
    a. The ACS shall support the following Alarm Management functionality:
        1) Create and modify user-defined alarms. An unlimited number of alarms shall be supported.
        2) Assign a time schedule or a coverage period to an alarm. An alarm shall be triggered only if it is a valid alarm for the current time period.
        3) Set the priority level of an alarm and its reactivation threshold. The ACS shall support up to 30 alarm priority levels.
        4) Define the time period after which the alarm is automatically acknowledged.
        5) Define the recipients of an alarm. Alarm notifications shall be routed to one or more recipients. Recipients shall be assigned a priority level which prioritizes the order of reception of an alarm.
        6) Define the alarm broadcast mode. Alarm notifications shall be sent using either a sequential or an all-at-once broadcast mode.
        7) Define whether to display the source of the alarm, one or more entities, or an HTML page.
        8) Specify whether an incident report is mandatory during acknowledgment.
        9) Associate an action to an alarm event.
        10) Import and acknowledge video system alarms.
    b. A user shall be able to add, delete, or modify an alarm if he has the appropriate privileges.
    c. Routing of alarms to specific client workstations shall be possible through the assignment of alarm recipients. The ACS shall also support alarm notification to an email address or any device using the SMTP protocol.
    d. Alarms shall be routed to the Surveillance UI for viewing and acknowledgement.
    e. The ability to create alarm-related instructions shall be supported through the display of one or more HTML pages following an alarm event. The HTML pages shall be user-defined and can be interlinked.
    f. User shall have the ability to acknowledge alarms, create an incident upon alarm acknowledgement, and snooze an alarm.

40. Visitor Management
    a. The ACS shall be capable of Visitor Management. A user shall be able to enroll or remove a visitor if he has the appropriate privileges. The ACS shall support check-in and check-out of visitors from the Surveillance UI.
    b. A visitor check-in wizard shall facilitate the enrollment process. The user shall specify the following information when enrolling a visitor:
        1) First name
        2) Last name
        3) Picture
        4) Company
        5) Phone number
        6) Reason for visit
        7) Visitor's escort
        8) Visit activation and expiration date
        9) Credential settings
        10) Visitor privileges
        11) Custom fields

c. The ACS shall support the creation of a pool of visitor credentials in advance. Existing visitor credentials shall be assigned to visitors during the check-in process.
d. The ACS shall permit cardholder groups to be designated as “available for visitors”. Users shall be able to define the access privileges for the cardholder groups (visitor cardholder groups) in advance. During visitor check-in, the user shall select the visitor cardholder group to associate with a visitor. All of the visitor cardholder group access privileges shall be automatically transferred to the visitor. This feature shall permit the creation of multiple types of visitor groups and associated privileges (for contractors, VIPs, day visitors, etc.). Visitors added to visitor cardholder group in the Surveillance UI shall be automatically updated in the Configuration UI cardholder group screen.
e. A visitor’s profile shall support the real-time modification of visitor information even after a visitor has checked-in.
f. The ACS shall also provide comprehensive visitor tracking and visitor reporting. Through the real-time tracking feature, the ACS shall generate a real-time and historical visitor activity listing in the Surveillance UI. The ACS shall also generate visitor-specific reports that provide comprehensive listings of visitors as well as full details on their movement while in your facility.
g. It shall be possible to exempt a visitor from any antipassback rules in effect.
h. The operator shall be able to print visitor badges during the check-in process. The printing of both paper badges (visitor without an assigned credential) and actual credentials shall be supported.

41. Real-time Tracking
    a. The ACS shall support real-time tracking of a particular entity through a dedicated tracking layout in the Surveillance UI. Real-time tracking layouts shall display both real-time activity and historical activity.
42. Report Generation
    a. The ACS shall support report generation (database reporting). Reports shall be accessible through a dedicated layout within the Surveillance UI and the Configuration UI. Quick access to all current reports shall be possible through a report quick access button.
    b. The ACS shall support both static and custom reports. There shall be no need for an external reporting tool to create custom reports and report templates. All report templates shall be created with the ACS user interface.
    c. Report generation shall not result in any degradation of system performance.
    d. The reporting layout shall consist of panes with settings (report length, filters, go and reset commands, etc.), the actual report data in column format, and a pane with display tiles. The user shall be able to drag and drop individual records in a report onto one or more display tiles to view a cardholder’s picture ID, playback a video sequence, or both.
    e. Reports are fully configurable. A user has the option of generating static reports from an existing list, generating reports from a list of user-defined templates, or creating a new report or report template. There shall be no notion of a static report. Each report can be customized to the current context.
    f. The ACS shall support the following types of reports:
        1) Configuration reports (cardholders, credentials, units, access rules, readers/inputs/outputs)
        2) Cardholder activity
        3) Door activity
        4) Area activity
        5) Area presence tracking
        6) Elevator activity and floor tracking
        7) Zone activity report
        8) Credential activity

9) Credential access status
10) Cardholder access status
11) Unit activity report
12) Audit trail report
13) Incident report
14) Time and attendance
15) Alarm report
16) Visitors report
17) Visitor activity report
18) Area presence report
19) Health
20) Zone

g. The user shall be able to customize the predefined reports and save them as new report templates. These templates can be used to generate reports on a schedule in PDF or Excel formats. Customization options shall include setting filters, report lengths, and timeout period. The user shall also set which columns shall be visible in a report. The sorting of reported data shall be available by clicking on the appropriate column and selecting a sort order (ascending or descending).

h. Alarm reports shall permit filtering on the following information:
1) Alarm
2) Alarm status
3) Source
4) Trigger
5) Triggered on
6) Acknowledged on
7) Acknowledged by
8) Current state
9) Acknowledgement reason

i. Visitor reports shall permit filtering on the following information:
1) First name
2) Last name
3) Company
4) Escort's first name
5) Escort's last name
6) Visit reason
7) Arrival date
8) Departure date
9) Custom fields

j. The user shall be able to click on an entity within an existing report to generate additional reports.

k. The ACS shall support the following actions on a report:
1) Print report
2) Export report to a PDF file
3) Export report to a Microsoft Excel file
4) Automatically email a report based on a schedule and a list of one or more recipients

43. People counting

a. The ACS shall be capable of people counting (or area presence tracking). The ACS shall be able to monitor and report the number of cardholders in an area in real-time and for all areas. Monitoring shall be based on the entire access control infrastructure, for both local areas and those in remote geographic locations.

b. The ACS shall report area presence counts in the Surveillance UI. Area presence tracks shall dynamically track the total number of cardholders in an area. Displayed data shall be updated dynamically. Area tacking shall be presented in a tree format, with areas nested within other areas.

c. The ACS shall be able to generate an area presence report listing the cardholders located in one or more areas, accessible through the Surveillance UI. It shall be possible to filter the report by area and time period. The report shall also include activity from sub-areas (nested areas). The area presence report shall include the following information:
   1) Area name
   2) Cardholder
   3) Last access

d. Through people counting, the ACS shall be able to generate First Person In and Last Person Out events. The First Person In event shall detect when the first cardholder enters an empty area. The Last Person Out event shall detect when the last cardholder leaves an area. It shall be possible to trigger actions from both events such as sending a message or triggering an alarm.

44. Scheduled Tasks
   a. The ACS shall support scheduled tasks. Scheduled tasks shall be executed on a user-defined schedule at a specific day and time. Recurring or periodic scheduled tasks shall also be supported.
   b. Scheduled tasks shall include all actions available within the ACS, including but not limited to:
      1) Sending an email (in the ACS or external system)
      2) Sending a message (in the ACS or external system)
      3) Triggering a macro (in the ACS or external system)
      4) Triggering an alarm (in the ACS or external system)
      5) Triggering an output
      6) Display an entity in the Surveillance UI
      7) Sound or silence a buzzer
      8) Add bookmark (camera-related)
      9) Go to preset (camera-related)
      10) Running a pattern (camera-related)
      11) Starting recording (camera-related)
      12) Stopping recording (camera-related)
45. Custom Fields (User-Defined Fields)
   a. The ACS shall permit the creation of custom fields. A maximum of 1,000 custom fields shall be supported.
   b. User shall be able to define a default value for a custom field.
   c. The creation of new custom field types shall be possible. New custom field types shall be based on the standard custom fields supported. They shall support user-defined values from which an operator must make a selection.
   d. Administrators have the ability to define which users can view and modify specific custom fields. This shall limit the access to custom field data to users with pre-defined privileges. The ACS shall support querying and report generation using custom fields.
   e. Custom fields can be grouped and ordered according to user-defined priorities.
46. Import Tool
   a. The ACS shall support an integrated Import Tool to facilitate the import of existing cardholder and credential data. The import of data shall be through the use the CSV file format. The tool shall be available from the Configuration UI.
   b. Full flexibility in selecting the fields import during an import session shall be available.
   c. The ACS shall also support re-importing a CSV file containing new information to update existing information in the ACS database. Re-importing shall enable bulk amendments to existing access control data.
   d. The Import Tool shall also support the ability to manually import data that has been exported from a third party database if it is in CSV format.

47. Software Development Kit (SDK)
    a. Integration with external applications and databases shall be facilitated through the use of an SDK. The SDK shall enable end-users to develop new functionality (standalone applications or services) to link the ACS to third party business systems and applications such as Badging Systems, Human Resources Management Systems (HRMS), and Enterprise Resource Planning (ERP) systems.
    b. The SDK shall be able to receive real time events from all ACS entities:
        1) Door Controllers (units)
        2) Input and Output (IO) modules (units)
        3) Doors
        4) Elevators
        5) Areas
        6) Zones
        7) Cameras
        8) Cardholders
        9) Cardholder groups
        10) Credentials
        11) Users
        12) User Groups
    c. The SDK shall support the following alarm functions:
        1) View alarms in real time
        2) Acknowledge alarms
        3) Change priority
        4) Change recipient
    d. IO linking: Receive the state of inputs, and control outputs.
48. Macros
    a. The ACS shall enable users to automate and extend the functionalities of the system through the use of macros. Macros shall be programmed with the Software Development Kit (SDK) to create sophisticated system behavior.
    b. A macro shall be executed either automatically or manually. In automatic mode, it shall be loaded in a background process and shall execute when a set of conditions are met. Macros shall be loaded into the ACS without requiring a system upgrade or re-installation.
    c. In the Surveillance UI, a macro shall be launched through hot actions.
49. Dynamic graphical Maps
    a. The ACS shall support Mapping functionality. Digital maps shall be used to represent the physical location of:
        1) Cameras
        2) Doors
        3) Alarms
        4) Zones
        5) Output Groups
    b. The mapping functionality shall be able to import maps in XAML format.
    c. It shall be possible to design dynamic maps using the SDK. Any functionality available through the SDK shall be available within maps.
    d. Mapping shall support the following drag-and-drop user actions
        1) Drag-and-drop a door from a map into a display tile for viewing
        2) Drag-and-drop a camera from a map into a display tile for viewing
    e. Graphical maps shall support mouse-based contextual pop-ups and associated actions:
    f. Over an area, the map shall display number of people in an area (People Counting)
        1) Over a door, the map shall allow the user to unlock the door
        2) Over an output group, the map shall allow the user to trigger an output

3) Over a zone, the map shall allow the user to view the status of the associated input(s).

g. Various actions shall be available within maps for execution through simple and intuitive double-click, right-click, or drag-and-drop functionality. Examples of actions available through maps shall include unlocking a door and acknowledging an alarm.

50. Audit Trails (Logs)
    a. The ACS shall support the generation of audit trails. Audit trails shall consist of logs of operator/administrator changes.
    b. Audit trails shall be generated as reports. They shall be able to track changes made within specific time periods. Querying on specific users, changes, affected entities, and time periods shall also be possible.
    c. The ACS shall support the following actions on an audit trail report:
        1) Print report
        2) Export report to a PDF file
        3) Export report to a Microsoft Excel file
51. Incident Reports
    a. Incident reports shall allow the security operator to create reports of incidents that occurred during a shift.
    b. The operator shall be able to create standalone incident reports or incident reports tied to alarms.
    c. Incident reports shall allow entities, events, and alarms to be added to support the report's conclusions.
52. Cabling shall be installed as specified herein, as recommended by the manufacture and as shown on the riser diagram.

C. IP Video Camera and Recording System
1. Overview
    a. Provide a completely operational IP Video Camera and Recording System. The system shall include but not be limited to viewing and recording software, viewing/archiving workstation, network switches, cabling, cameras, housings, encoders/decoders, integration with the access control system, installation, programming, customer training.
    b. The CCTV system shall fully integrate to the access control system as specified previously. A single graphical user interface shall used to incorporate all alarm functionality of the required access control solution as well as the viewing of both live and recorded video.
    c. The CCTV system shall be connected to the independent security local area network. It is this contractor's responsibility to provide network switches, and all associated network cabling for a complete and operational system. The network shall be capable of interfacing to the owner's local area network for future use.
    d. Recording parameters shall be defined as supporting all cameras/devices detailed for 30 days minimum, 15 frames/images per second, 50% motion activity and minimum compression quality. Storage will be accomplished via Owner's SAN coordinate these requirements and provide recommended storage capacity to owner and document through the submittal process how the proposed storage solution was calculated.
    e. The IP video camera and recording solution must support and inherently be able to utilize both Unicast and Multicast for all components of the solution.
    f. Video solution shall be capable of supporting multiple streams from all cameras and encoders utilized within the solution. There shall be no limitation on the quantity of streams which can be processed and made available to the solution and users by the video solution software. The only limitation of support of simultaneous streams shall be by the camera or encoder.

g. Video camera and recording system shall be capable of supporting at minimum one defined resolution/frame rate and encoding scheme (i.e. MPEG4) for recording and a second defined resolution/frame rate and encoding scheme (i.e. MJPEG, MPEG4, H264) for live view. Any proposed solution which cannot achieve this minimum requirement must provide the necessary additional licenses and/or equipment to meet this functional requirement.

h. Video solution must be capable of managing; controlling and setting up any and all required Multicast sessions. If a client workstation requires or has access to a particular IP camera then the proposed solution must create and enter the client workstation and IP camera into a created Multicast session.

i. The video server shall not have to re-create and/or re-produce said live video streams which would negatively affect the performance of the video server, also limiting the number of IP cameras/devices said server can support.

2. Manufactures
   a. The system described herein is based on the Omnicast System as manufactured by Genetec. Additional manufacturers:
      1) ONSSI
      2) Milestone
      3) Or Equal
3. Products
   a. IP Based Video Recording and Viewing Software (RVS)
      1) The RVS shall be furnished and installed on all security workstations/servers as shown on the drawings.
      2) The storage, as specified above, shall be recorded to a RAID5 server with 30 days of storage utilizing Windows 2008 software.
      3) The RVS shall allow users to activate all live viewing controls using a standard PC. All standard camera switching and automation functions of a CCTV keyboard shall be available using a PC keyboard.
      4) The RVS shall allow for the configuration of a time zone for each camera connected to a DVS and for each SSM. For playback review, users shall have the ability to search for video based on the following options:
         a) Local time of camera
         b) Local time of the SSM
         c) Local time of user's workstation
         d) GMT Time
         e) Other time zone
      5) The RVS shall have the capability of creating camera sequences with the following functionality:
         a) Each Sequence shall have a maximum of 150 cameras.
         b) Each camera in the sequence shall have its own individual dwell time, from 1 to 999 seconds.
         c) Each entry in a sequence shall have the capacity to trigger camera presets, patterns or auxiliaries.
         d) Multiple users shall be able to view the same camera sequence simultaneously. Users shall be able to pause the sequence without affecting other viewers.
      6) The RVS shall have the capability to interface with video walls via a CCTV keyboard connected to a DVS decoder.
      7) The RVS shall allow live viewing of video and live audio communications at each security workstation.
      8) It shall have the following minimum capabilities:
         a) Shall enable live monitoring of 1 to 16 video streams simultaneously on a single 1024x768 monitor.

b) Shall support as many monitors as the PC video adapters are capable of taking. Each monitor should be able to display 1 to 16 video streams.
c) Shall enable operators to choose from a number of possible camera display patterns ranging from 1 tile to 16 tile display patterns.
d) Shall allow operators to control (Pause/Play, skip forwards, skip backwards) Camera sequences without affecting other operators' ability to view and control the same sequence.
e) Shall display all analog monitors attached to the system.
f) All cameras, sequences and analog monitors shall be displayed in a logical tree. The operator shall have tools to quickly find any camera based on partial name or description.
g) The operator shall be able to drag and drop a camera from a tree of cameras into a window or an analog monitor icon for live viewing.
h) The operator shall be able to drag and drop a camera sequence from a tree of cameras into a window or an analog monitor icon for live viewing.
i) Video streams may be assigned to tiles that are not presently visible in the currently displayed pattern.
j) Shall support Mapping functionality, where digital maps are used to represent the physical location of cameras and other devices throughout the surveillance system. Maps shall have the ability to contain hyperlinks so as to create a hierarchy of interlinked maps. The mapping functionality shall be able to import maps from any graphical software supporting BMP, JPEG and/or GIF image formats.
k) The operator shall be able to drag and drop a camera from a map into a window for live viewing.
l) The operator shall be able to click on an icon in a map to initiate a camera preset, run a pattern or send a I/O stream.
m) Shall support the procedure functionality, where procedures can be triggered to appear during a certain event and can be used to provide detail instructions to the operator as to the actions he should take.
n) Shall support touch screen technology.
o) The operator shall be able to optimize the monitor for touch screen technology.
p) Shall support digital zoom on live camera video streams
q) Shall support guard-tour (automatic sequencing of camera layouts) with a pre-assigned dwell time through pre-defined monitor views (for example: rotating views from a quad view to a 16 camera view to a full view at specified intervals).
r) Shall allow the user to choose any of the video streams associated to a camera for viewing.
s) Each Live Viewer shall have an icon indicating the number of alarms in queue that are assigned to the logged on user. The alarms shall also be displayed in an alarm pane at the bottom of the screen. The alarm pane shall display the currently active alarms as well as alarms acknowledged, auto-acknowledged, forwarded and snoozed.
t) Shall enable the user to perform the following actions on alarms: Acknowledge (default method), Acknowledge (alternate method), Acknowledge (custom method), Snooze (for a preset number of seconds), Forward to other users on the system, Show a procedure associated to the alarm, Show the history of an alarm, and Launch the Archive Player to review past alarms.

u) Shall enable the user to spontaneously trigger alarms based on something he sees on a camera. The camera of interest shall be sent as part of the alarm to selected users.

v) Shall allow for audio communication with DVS units. The operator shall have the option of using full duplex or half duplex mode (to act as an IP intercom system). Audio shall be archived on the same storage as video from cameras.

w) The operator shall easily navigate between this application and the other CSA applications (if he has access rights) by single point and click functionality.

x) The operator shall be able to control pan-tilt-zoom, iris, focus, dome relays, dome patterns, dome presets and the dome configuration menus. He/she shall also be able to set an unlimited number of presets and patterns

y) Users shall be able to control PTZ functions with a standard PC joystick.

z) Each operator shall be assigned a PTZ priority ranging from 1 to 255. This allows a prioritization between operators on who has control over a camera.

aa) The system shall allow users to have the ability to lock PTZ control. Users with a higher PTZ priority can unlock PTZs from users with lower priorities.

bb) Shall allow operators to bookmark important events for later retrieval on any archiving camera. Operators can uniquely name each bookmark in order to facilitate future searches.

cc) The operator shall have the capability to activate or de-activate viewing of all system events as they occur.

dd) Shall allow operators to view an instant replay of the video for any archiving camera. The operator will be able to define the amount of time he wishes to go back (unlimited).

ee) The Instant Replay function shall playback video at the time of the alarm when activated in a tile displaying an alarm. With a graphical timeline representation, the user shall be able to control what time he is looking at. The instant replay pane can be undocked to allow video window resizing.

ff) Users shall be able to take snapshots of live video feeds in the Live Viewer and be able to save or print the snapshots.

gg) Shall allow operators to add bookmarks or view their instant replay in the Archive Player application by clicking on a single button in the Instant Replay tab.

hh) The user shall have the ability to execute frequently used macros from a pane or a function key in the Live Viewer.

ii) The user shall be able to view the same camera multiple times in different tiles.

jj) Users shall be able to archive live video streams locally on the workstation. No SSM need to be installed on the workstation. Recording is activated and terminated manually by the user. Two recording methods are available to the user.

kk) Tile archiving: Video displayed within a specific tile is recorded. Cameras can be switched within a tile.

ll) Layout archiving: Video streams displayed in all tiles within a specific layout are recorded. Cameras can be switched within the tiles.

mm) Users shall be able to display a layout of video streams within a PC monitor that removes all non-video graphical components. Delimiters between tiles are two pixels wide.

nn) Users shall be able to switch easily between a Simple and an Advanced operation mode. In the Simple mode, only the most common commands shall be available.

oo) The Live Viewer shall enable the administrator to freeze the application's workspace to certain users so that look and feel cannot be changed by the user.

pp) Shall allow the local user (with permissions) to remotely control the workspace of other Live Viewer applications in the system.

9) Provide Genetec Omnicast or equal.

b. Video Server

1) Video storage shall be accomplished through Owner's SAN. Provide all coordination and scope required to connect to Owner's SAN

c. Security Control Workstation

1) Provide security workstation clients to be located as directed by Owner.

d. Monitors

1) Provide 42" LCD high performance color monitors as shown on the drawings. Monitors shall be wall mount. Coordinate with architect as required.

2) Each monitor shall be connected to the security workstation as specified above. Provide KVM extenders as required. KVM extenders shall be located in the main equipment rack.

3) Provide BOSCH 42RTH or equal.

4) Wall mount brackets: Provide wall mount brackets and locate per the owner's requirements. Provide Peerless or equal.

D. Indoor Fixed Cameras and Housings

1. General Camera Requirements

a. The interior fixed cameras shall be Axis P3343 cameras will be set to monitor areas and go to alarm if motion detected within preset field of view. Upon alarm, the Axis Q6032 PTZ camera will either be preset to scan to pre-configured alarm location, or camera alarm indicator will alert dispatch to manually move PTZ camera to identify alarm condition. Exterior fixed cameras shall be Axis P3343-VE.

E. General

1. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.
2. Delivery, Storage and Handling:
3. Deliver, store, protect and handle products in accordance with recommended practices listed in Manufacturer's Installation and Maintenance Manuals.

a. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.

b. Inspect and report concealed damage to carrier within specified time.

c. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location shall be protected to prevent moisture from entering enclosures and material.

d. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.

e. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably to insure that the tilting does not impair the functional integrity of the equipment.

F. Work
1. Loose materials shall not be stored on-site. A "gang box" is acceptable to be placed in a location agreeable to the Owner and the General Contractor. The Installer is responsible for all equipment and materials and for their delivery until the system is deemed complete and accepted by the Owner.
2. Protect existing in spaces where work is being performed to protect it from damage and from the accumulation of dirt.
3. Any ceilings, walls, floors, furniture, equipment, furnishings, etc., damaged by the work of this Section shall be replaced, or at the Owner's option, repaired with similar materials, workmanship and quality.
4. Clean and touch up all equipment, materials and work sites at the completion of work in each area.

G. Equipment racks, Cabinets and Brackets
1. Securely mount equipment racks, cabinets and wall mounted relay brackets to the building structure. Proper supports such as 3/8" lag screws and expansion anchors shall be used. Proper quantity of supports shall be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.

H. Installation
1. All cabling shall be installed in conduit where indicated on plans, or shall be installed open using other methods, approved by architect, such as J-Hooks, cable tray & snake tray.
   a. Install wiring, per manufacturers recommendations.
   b. All wiring shall be new, concealed in pipe where exposed.
   c. Install wiring for detection and signal circuit as specified. Make wiring connections to new or existing door hardware devices as required
2. Control Circuit Wiring:
   a. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
   b. All housings are to be located as specified and shown on drawings.
   c. Make installation in strict accordance with approved manufacturer's drawings and instructions.
   d. The Installer shall provide necessary transient protection on the AC power feed, all station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
3. Splices, Taps, and Terminations:
   a. Make splices, taps and terminations on numbered terminal punch blocks in junction, pull, and outlet boxes, terminal cabinets and equipment enclosures.
   b. Identification of Conductors and Cables:
   c. Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
4. Weatherproofing:
   a. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

I. Grounding
   1. General:
      a. In general, the grounding shall be as specified, as indicated on the Drawings and as required by the Electrical Code and Local Authorities.
   2. Methods:
      a. Provide equipment grounding connections for integrated sound, voice and video systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
      b. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
      c. The installer shall provide all necessary transient protection on the AC power feed and on all station lines leaving or entering the building.
      d. The installer shall note in his system drawings, the type and location of these protection devices as well as all wiring information.
      e. The installer shall furnish and install a dedicated, isolated earth ground from the central equipment rack and bond to the incoming electrical service ground buss bar.

J. Integrated Security System Testing
   1. Each device as specified in the specification shall be tested in accordance with the manufactures guidelines and owner’s requirements.
      a. Provide test reports upon completion.

K. Cleaning Up
   1. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.
   2. The interior of all boxes and cabinets shall be left clean; exposed surfaces shall be cleaned and plated surfaces polished.
   3. Repair damage to finish surfaces resulting from work under this Section.
   4. Remove material and equipment from areas of work and storage areas.
   5. All equipment shall be clean from dirt, dust, and fingerprints prior to final acceptance.
   6. Touch up all damaged pre-finished equipment using materials and methods recommended by the Manufacturer.

L. Project Closeout
   1. Provide close out submittals as required herein and in SECTION 01 77 00 - PROJECT CLOSEOUT including the following close out submittals.
      a. Operation and Maintenance Manuals
      b. Record Drawings.
      c. Test Reports.
      d. Extra Materials.
   2. Obtain written receipts of acceptance close out submittals submitted. Receipts shall specifically detail what is being delivered (description, quantity and specification section) and shall be dated and signed by firm delivering materials and by the Owner's Representative.

2.40 MULTIPLE CHECK METERING SYSTEM

A. Provide a system of check meters consisting of Multiple Meter Unit Cabinets equal to E-MON D-MON MMU Series. Multiple Meter Cabinets shall consist of 8, 16 and 24 meters as indicated on Plans. Each meter shall meet the following criteria:
   1. Meter shall be fully electronic with 4-line by 20-character backlit LCD display showing kwh, kW demand (with peak date and time), power factor per phase, real-time load in kW, Amps per phase and Volts per phase.
   2. Meter shall utilize 0-2 volt AC output current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensor shall be of split-core configuration to allow installation without disconnecting cabling, etc. Sensors shall be available from 100 amp to 3200 amp. Sensors shall be optionally available to solid-core configuration (100 & 200 amp.)
   3. Meter shall be field programmable for meter date/time and ID code for communication options.
   4. Meter shall provide installation diagnostics on display.
   5. Meter shall be enclosed in MMU NEMA 1 enclosure (standard) with padlocking hasp & mounting flanges for indoor/outdoor installation (stand alone) with one 1 1/16" KO on bottom of enclosure.
   6. Meter shall be UL/CUL Listed to latest applicable standards for safety.
   7. Meter shall meet or exceed NSI C12.20 accuracy standards.
   8. Meter shall provide non-volatile memory to maintain reading during power outages.
   9. Meter shall store interval data or kWh and kVARh for up to 72 days in first-in first-out formal. (Standard firmware).
   10. Meter shall be capable of daisy-chain or star connection using RS-485 communications in combinations of Class 3200s, 3400s, 5000s, IDR-8s, IDR-16s not to exceed 52 devices. Cabling shall be available terminal block (3-conductor), 18-22AWG, up to 4,000 cable feet total.
   11. Meter shall be provided with the following communication protocols:
       a. Requires third-party EMS/BMS system supplied by others.
          1) Modbus RTU Communications (Replace EZ7 in model with RTU when ordering)
          2) BACnet MS/TP (Replace EZ7 in model with BAC when ordering)

B. Multiple Meter Unit Cabinets shall be prewired complete with voltage feeds.

C. Provide software package to be installed in ATC Contractor's PC terminal. Provide start-up services by Factory Authorized Manufacturers Representative.

D. Acceptable Manufacturers:
   1. E-Mon D-Mon
   2. National Meter Industries
   3. Square D
   4. Or Equal

E. Provide 4 hours of owner training.

PART 3 - EXECUTION

3.1 WORK COORDINATION AND JOB OPERATIONS

A. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.

B. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.

C. Furnish to General Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.

D. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades' equipment.

E. Lighting fixtures in mechanical spaces or utility/ storage rooms shall only be installed after all mechanical equipment is in place.

3.2 PLANS AND SPECIFICATIONS

A. Plans:
1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets, and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and as indicated on the approved coordination drawings.

B. Specifications:
1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.

3.3 IDENTIFICATION

A. Equipment shall be marked for ease of identification as follows:
1. Provide screw-on nameplates on switchboards, panelboards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of 1/4" high. Nameplates on panelboards shall have the following information.
a. Line 1 - Panel designation in 1/2" high letters.
b. Line 2 - Utilization voltage in 3/8" high letters.
c. Line 3 - Distribution source "Fed from " in 1/4" high letters.

2. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panelboards. Spare circuits shall be penciled.
3. Color coding schedules. If there is more than a single system voltage, different voltages shall have separate color codes, as previously specified. A copy of the color code schedule shall be affixed to each secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panelboard door.
4. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of coverplate.
5. Special system outlet boxes concealed above hung ceilings shall be identified as to system by spray painting during roughing. The following systems shall be identified.
   a. Fire Alarm - red.
   b. Normal/Emergency - yellow.
   c. Security - blue.
   d. Sound - green.
6. Wiring device plates on devices connected to normal-emergency circuits shall be red in color.
7. All conductors in boxes larger than standard outlet boxes, in all wireways, trench headers, etc. shall be grouped logically and be identified.
8. Grounding conductors and neutrals shall be labeled in panels, wireways, etc. as to circuits associated with.

3.4 PROTECTION AND CLEANUP

A. Protection:
   1. Materials and equipment shall be suitably stored and protected from weather.
   2. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.
   3. Be responsible for maintenance and protection of material and equipment until final acceptance.

B. Cleanup:
   1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.
   2. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.
   3. Particular attention is called to Section 110-12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

3.5 PORTABLE OR DETACHABLE PARTS

A. Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

3.6 SAFETY PRECAUTIONS

A. Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

3.7 MOUNTING HEIGHTS

A. All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.
   1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.
   2. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
   3. Clock outlets - 84 inches.
   4. Fire alarm pull stations - 48 inches.
   5. Fire alarm audio visual signals – 80-96 inches or 6 inches below ceiling, whichever is lower.
   6. Panelboards for lighting, power, telephone, and other auxiliary systems - 78" to top.
   7. Equipment located in lobbies shall be located as detailed on architectural drawings or as directed by Architect.
   8. All receptacles, light switches, fire alarm signals, and clocks sharing a common location shall be symmetrically arranged.
   9. Exterior and interior wall brackets shall be as detailed on architectural drawings or as directed by Architect.

B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

3.8 WORKMANSHIP AND INSTALLATION METHODS

A. Work shall be installed in first-class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush-mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans.

B. Supports:
   1. Support work in accordance with best industry practice and by use of standard fittings.
   2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
   3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.
   4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.

5. Provide 3/4" thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with 2 coats of white paint.
6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4" air space between building surfaces and work.
7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.
9. Support surface or pendant mounted lighting fixtures:
    a. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
    b. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
    c. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
    d. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturer's standard tube hangers with swivel aligner and canopy in public areas. Provide non-standard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
10. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.
11. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.
12. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.
13. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage as required to distribute the weight in a safe manner.
14. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.

C. Fastenings:
1. Fasten electric work to building structure in accordance with the best industry practice.
2. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
    a. Wood -- with wood screws.
    b. Concrete and solid masonry -- with bolts and expansion shields.
    c. Hollow construction -- with toggle bolts.
    d. Solid metal -- with machine screws in tapped holes or with welded studs.
3. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
    a. At field poured concrete slabs, provide inserts with 18" minimum length slip-through steel rods, set transverse to reinforcing steel.
    b. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
4. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.

5. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.
6. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via traps.

D. General Raceway Installation:
1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.
2. Raceways for normal-emergency or emergency only wiring cannot contain other conductors.
3. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.
4. Raceways run on trapeze hangers shall be secured to the trapeze.
5. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.
6. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.
7. Where raceways terminate below equipment and there is no direct metal to metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.
8. All empty raceways shall be provided with a pull wire.
9. All raceway sleeves, stub-ups, or stub-outs, where not connected to a box or cabinet, shall be terminated with a bushing.
10. All raceway joints shall be made up tight and no running threads will be permitted.
11. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.
12. All vertical raceways passing through floor slabs shall be supported.
13. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
14. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.
15. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6 inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.
16. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
17. Raceways passing between refrigerated and non-refrigerated spaces and those penetrating enclosures with air movement shall be provided with seals.
18. Raceways feeding fire and jockey pumps shall be rigid metal conduit either run below slab or inside 2 hour rated enclosure. Final connections to motors shall be liquidtite flexible conduit.
19. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
20. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
21. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.

22. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.
23. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.
24. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.
25. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.

E. General Outlet Box Installation:
1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Thru the wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.
3. Remove knockouts only as required and plug unused openings.
4. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways and where bar rangers are not provided.
5. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.
6. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, structural members, etc.
7. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.
8. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.
9. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. "Reasonable change" shall be interpreted as movement within 10 feet of location shown.
10. Obtain dimensioned plan from Architect for floor outlets.
11. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation:
1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.
2. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.
3. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.
4. All taps and splices shall be insulated equal to that of conductor insulation.
5. All conductors of each feeder in pull boxes etc. shall be grouped, tied together, supported, and identified.
6. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
7. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
8. Provide support for conductors in vertical raceways in accordance with Article 300-19.
9. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.

10. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO "PTA" series.
11. Grounding conductors are to be identified as to associated power circuits.

G. Type MC Cable Installation:
1. Where cable is permitted under the products section, the installation of same shall be done in accordance with code and the following:
   a. Cable shall be supported in accordance with code. Tie wire is not an acceptable means of support. Horizontally run cable supports such as Caddy WMX-6, and clamps on vertical runs such as Caddy CJ6 shall be used. Where cables are supported by the structure and only need securing in place, then Ty-raps will also be acceptable. Ty-raps are not acceptable as a means of support. All fittings, hangers, and clamps for support and termination of cables shall be of types specifically designed for use with cable, i.e., Romex connectors not acceptable.
   b. Armor of cable shall be removed with rotary cutter device equal to roto-split by Seatek Co., not with hacksaw.
   c. Use split "insuliner" sleeves at terminations.
   d. Any cable system used in conjunction with isolated ground circuits shall have both an isolated ground conductor and an equipment ground conductor.

H. Stranded Conductor Installation:
1. If Contractor selects stranded conductors for # 10 AWG and smaller, terminate such conductors as follows:
   a. No stranded conductor may be terminated under a screwhead. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts "STA-KON" type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT-145C which prevents opening of tool until full compression action is completed.
   b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.
2. Stranded conductors will not be allowed for fire alarm work.

I. Accessibility:
1. Electrical equipment requiring service or manual operation shall be accessible.
2. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

J. Vibration Elimination: All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.

K. Wiring Device Gaskets: Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

3.9 FEEDER CIRCUITS

A. Provide feeders as called for on the drawings.

B. Feeders shall be defined as any circuit originating from the main building switchboard and/or distribution panels.

C. All feeder conductors shall be continuous from origin to panel or equipment termination without splicing.

D. All feeders shall be conductors pulled into raceways. Cable systems are not allowed for feeders unless specifically indicated.

3.10 BRANCH CIRCUITS

A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, as required to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses, etc.

B. Provide dedicated neutrals for all fluorescent lighting circuits and all circuits originating from panelboards fed from K-rated transformers.

C. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Combining of circuits and raceways will be allowed up to a 3 phase, 4 wire circuit or 3 phase 6 wire (dedicated neutrals) in a single raceway. Any combination of homeruns such as this, however, shall be indicated on record drawings. When a common grounded conductor is used for more than one circuit, the arrangement shall be such that a receptacle, fixture, or other device may be removed or disconnected without disconnecting the grounded conductor for other circuits. Ground fault circuit breakers and isolated ground outlets shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.

D. Circuits feeding three phase equipment shall not be combined into common raceways, unless specifically indicated.

E. All wiring in panelboards and cabinets shall be neatly formed and grouped.

3.11 FIREPROOFING AND WATERPROOFING

A. Fireproof and waterproof all openings in slabs and walls.

3.12 CUTTING AND PATCHING

A. Penetrations through construction as required for the Work of this Section:
   1. Coring: Perform all coring for require work.
   2. Notify Masonry Sub-Contractor of exact locations and sizes for openings required in masonry, to be executed under Section 042000 – Unit Masonry, utilizing lintels furnished per Section 055000 – Metal Fabrications.
   3. Cut openings in new and existing non-masonry construction where required for penetrations. All cutting shall conform to the requirements of Section 017329 – Cutting and Patching, and 024119 – Demolition.
   4. Refer to Section 024119 – Demolition for restrictions on all alterations to structural elements.

B. Patching at penetrations through construction as required for the Work of this Section:
   1. Notify Masonry Sub-Contractor when plumbing work is complete at penetrations through masonry construction, and ready for patching under Section 042000 – Unit Masonry.
   2. Notify appropriate Sub-Contractors when plumbing work is complete at penetrations through non-masonry construction, and ready for patching under Section in Division 9 – FINISHES.

3.13 ELEVATOR COORDINATION

A. Elevator Electrical Work:
   1. Several items pertaining to elevator electrical system shall be provided by Electrical Subcontractor as follows:
      a. Power source to elevator machine room including fused disconnect switch and wiring between disconnect switch and controller for each elevator.
      b. Power source to elevator machine room including fused disconnect switch (120 volt) for elevator signal system and cab light for each cab.
      c. Light, switch, and GFCI receptacle in each pit.
      d. Light, switch, and GFCI receptacle in machine room.
      e. Junction box in machine room with five control modules from fire alarm system for elevator recall to prevent cab opening on a fire floor.
      f. Junction box in machine room for cab telephone with (1) 1" conduit with (2) CAT 6 telephone cables to main telephone demarcation backboard.

3.14 MECHANICAL SYSTEM COORDINATION

A. The Mechanical System Subcontractor will be providing various items of mechanical services equipment and control apparatus. Electrical Subcontractor shall furnish disconnect switches and starters and connect up power wiring to this equipment.

B. The Mechanical and Electrical Subcontractor shall closely coordinate their respective portions of work.

C. If, due to local regulations, electric heating equipment furnished by the mechanical systems subcontractor is required to be installed by licensed electricians in order to allow connection by Electrical Subcontractor's licensed electricians, it will then be Mechanical Subcontractor's responsibility to engage and pay for services of such licensed electricians.

D. Power wiring to be provided by Electrical Subcontractor is the line voltage power supply wiring. Control wiring is responsibility of Mechanical System Subcontractor unless specifically indicated on electrical drawings, or in this Division of the specifications. Temperature Control Subcontractor shall refer to electrical drawings for location of all magnetic starters.

E. 120 volt control wiring source to temperature control panel is the responsibility of Electrical Subcontractor.

3.15 DISTRIBUTION EQUIPMENT TESTING

A. All dry-type transformers, individual motor starters, switchboard and main distribution panels, motor controls, motor control centers, feeder conductors, and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 1995 Acceptance Testing Specifications of the International Electrical Testing Association.

B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment, which is to be tested.

C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.

D. Switchboard and Main Distribution Panels:
   1. Visual Inspection:
      a. Check for foreign material within bus enclosure.
      b. Check for missing hardware.
      c. Inspect entire assemblies for transit damage or factory defects.
      d. Check for all bus dimensions and bracing per specifications.
      e. Check ratings of current transformers and potential transformers.
      f. Check ratings of all protective relays per drawings.
   2. Physical Inspection:
      a. Torque all bus hardware to proper tension.
      b. Circuit breaker interlocks all work properly.
      c. All doors and hinged panels open and close properly.
      d. Relay blocking removed from all control and protective relays.
      e. All circuit breakers operate, close and trip mechanically.
      f. Torque all feeder conductors to terminal manufacturers' recommendations.
   3. Electrical Testing:
      a. Breakers operated electrically trip and close from local and remote positions.
      b. All circuit breakers calibrated to manufacturer's respective time current curves as specified.
         1) Long time pick-up amps.
         2) Long time delay tripping at 300% of current setting.
         3) Resets okay at 80% of pick-up value.
         4) Short time pick-up current.
         5) Short time delay trip time at 105% of setting.
         6) Instantaneous minimum pick-up current.
         7) Ground Fault
      c. All protective relays calibrated to manufacturer's characteristic time curves for pick-up, drop-out, instantaneous and time delay.
      d. All instruments calibrated for accuracy.
      e. Protective relay schemes to be electrically tested by primary injection of current through current transformers and the tripping of associated circuit breakers.
      f. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohometer type instrument. Relays also to be insulation resistance tested.

E. Transformers:
   1. Visual inspection for transit damage such as broken porcelain, brazed connections broken off, core shifted on frame, winding damage, etc.
   2. Insulation resistance tests in accordance with U.S.A.S.I. Standard C571222 and NEMA TRI-2.055.
   3. D.C. over-potential test procedures and A.C. voltage values for factory proof testing of C57.12968 and NEMA TRI-2.055. The ratio applied for converting A.C. test potential to equivalent D.C. value is 1.6.
   4. Acceptance test voltage for new transformers at D.C. value will be 75% of equivalent A.C. voltage used for factor proof testing the value will be 65%.
   5. Transformers shall be subjected to a ratio and polarity test to prove the polarity and winding ratio as in accordance with nameplate specifications.
   6. Torque all connections to terminal manufacturers' recommendations.

F. Starters:
   1. Visual inspection to determine:
      a. Shipping damage.
      b. Proper bussing and contactor sizes.

c. Correct overload relay heater ratings. Any incorrectly sized overloads shall be replaced by the contractor who originally provided same.

2. Electrical Testing:
   a. Electrical operation of control relays, timing relay, and contactor coils.
   b. Insulation resistance test on all current carrying bus to ground and between phases.
   c. Calibration check of overload heater to ascertain tripping point and time delay at 300% of heater rating.

G. Conductors: All secondary service conductors and all feeder conductors from switchboards and distribution panels shall be tested.
   1. Visual and mechanical inspection: Conductors to be inspected for physical damage and proper connection and sizing in accordance with single line diagram.

      Conductor connections shall be torque tested to manufacturer's recommended values.
   2. Electrical Tests: Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.

      Perform continuity test to insure proper conductor connection.

H. Emergency Systems:
   1. Engine Generator - Prior to the emergency generator test specified under the emergency generator specification, the testing contractor shall perform the following:
      a. Visual and Mechanical Inspection:
         1) Inspect for physical damage.
         2) Compare nameplate rating and connection with specifications and single line diagram.
         3) Inspect for proper anchorage and grounding. Verify engine cooling and fuel system integrity.
      b. Electrical and Mechanical Tests:
         1) Perform a dielectric absorption test on generator winding with respect to ground. Determine polarization index.
         2) Perform phase rotation test to determine compatibility with load requirements.
         3) Test protective relay devices in accordance with applicable sections of these specifications.
         4) Perform dc over potential test between winding and ground.
   2. Automatic Transfer Switches:
      a. Visual and Mechanical Inspection:
         1) Inspect for physical damage.
         2) Verify that the short circuit withstand rating exceeds the available short circuit duty.
         3) Compare equipment nameplate information and connections with single line diagram and report any discrepancies.
         4) Check switch to ensure positive interlock between normal and alternate sources. (Mechanical and Electrical).
         5) Check tightness of all control and power connections.
         6) Perform manual transfer operation.
         7) Ensure manual transfer warnings are attached and visible to operator.
      b. Electrical Tests:
         1) Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
         2) Measure contact resistance in normal and alternate source position.
         3) Set and calibrate in accordance with the project electrical engineer's specifications.

a) Voltage and frequency sensing relays.
b) All time delay relays.
c) Engine start and shutdown relay.

c. Perform automatic transfer by tests.
a) Simulating loss of normal power.
b) Return to normal power.
c) Simulating loss of emergency power on return to normal.
d) Simulate all forms of single phase conditions.

d. Monitor and verify correct operation and timing.
a) Normal voltage sensing relays.
b) Engine start sequence.
c) Time delay upon transfer.
d) Alternate voltage sensing relays.
e) Automatic transfer operation.
f) Interlocks and limit switch function.
g) Timing delay and retransfer upon normal power restoration.
h) Engine cooldown and shutdown feature.

I. Grounding Grids or Electrodes: Measurement of resistance from ground grids or electrodes to earth to determine adequacy of grounding system in building and compliance with specifications and/or electrical code.

J. Settings of Adjustable Devices: Using the result of the fault current and coordination study specified hereinafter, the Testing Contractor shall set all adjustable devices.

K. In addition to the testing requirements of this Section refer to Section 01810 for additional requirements.

3.16 FAULT CURRENT AND COORDINATION STUDY

A. Employ the manufacturer of the secondary distribution equipment or an independent organization to perform a fault current and coordination study to ensure that the system provided is a selectively coordinated system from the incoming mains to the branch circuit panelboards.

B. The report shall be submitted in a standard format and shall include the fault current availability at various points in the distribution system, breaker coordination curves and recommended settings of all adjustable devices in the system.

3.17 STORAGE AND INSTALLATION OF EQUIPMENT

A. The electrical subcontractor shall store and install electrical equipment and wiring listed for dry locations only after the building is watertight.

3.18 CONSTRUCTION WASTE MANAGEMENT

A. Comply with Division 1 requirements for construction waste management and recycling.

3.19 DEMOLITION

A. Demolition of Existing Electrical Work:
   1. Disconnect all existing materials, fixtures and equipment indicated to be salvaged.
   2. Disconnect and cap all existing electrical services from building as indicated on drawings.
   3. Notify General Contractor when existing fixtures, materials, equipment and other features are ready for removal, salvaging, and disposal under Section 024119 – Demolition.

3.20 FIRESTOP SYSTEMS:

A. General: Install Firestop systems at all fire-rated construction where penetrated by the Work of this Section.

B. Refer to Section 078400 – Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

END OF SECTION

SECTION 260000

ELECTRICAL

(Trade Bid Required)

Trade Contractors on this CM at Risk project are required by law to provide Payment and Performance Bonds for the full value of their Trade Contracts, and Trade Contractors must include the full cost of the required Payment and Performance Bonds in the Bid price they submit in response to this RFB.

Bids will only be accepted from Trade Contractors pre-qualified by the Awarding Authority.

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Time, Manner and Requirements for Submitting Sub-Bids: Refer to “Request for Trade Bid- Trade Subcontract.”

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. All Work of Section 260000 – ELECTRICAL

2. All Work of Section 270000 – TECHNOLOGY (Filed Sub-Sub Bid to 260000)

3. All Work of Section 230548 – VIBRATION CONTROL AND SEISMIC RESTRAINT

4. Refer to Construction Manager’s “Request for Bid- Trade Subcontractor- Bid Package- Electrical Work,” for additional information.

END OF SECTION

SECTION 260800
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
2. Division 23 HVAC
3. Division 26 Electrical

1.03 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
1. Main distribution panel
2. Switchboards
3. Panelboards
4. Grounding
5. Lighting Control Devices
6. Lighting
7. Emergency lighting
8. Emergency Generator
9. Public Address System
10. Technology Systems, including telephone and data
11. Security systems

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.02 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
1. The system or assembly is completely installed and functional
2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
3. All contractor-performed start-up procedures and tests are complete.
4. The system or assembly is ready for the Owner to take beneficial use.

3.03 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
1. Main distribution panel
2. Panelboards and switchboards
3. Lighting Controls
4. Emergency lighting
5. Grounding
6. Emergency Generator
7. Emergency Power System
8. Public Address System
9. Technology Systems, including telephone and data
10. Security Systems

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
   2. Division 26 Electrical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.04 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.02 SUMMARY above for the sections) for review.

3.05 SAMPLE FORMS

Installation Checklist
Panelboards

Complete for each Panelboard
Panelboard ID# from drawings::
Reference Specification: 16100

Model Verification

	Specified	**Submitted**	**Installed**
Manufacturer	Eaton-Cutler Hammer, General Electric, Square D Co., Siemens		
Model Number			
Serial Number	N/A	N/A	
Capacity			

Installation Checks

ID	**Description**	**Pass**	**Fail**	**Notes**
1.	Panelboards have hinged front cover, entire front trim hinged to box and standard door within hinged trim cover.	☐	☐	
2.	Directory card with transparent protective cover mounted inside panel door.	☐	☐	
3.	Panelboards shown with a neutral shall have a full size insulated neutral bar installed	☐	☐	
4.	Panelboards shall have Bolt on Circuit breakers	☐	☐	
5.	Distribution panelboards shall have main circuit breakers; breakers larger than 600 amps shall be bolt on and shall be microprocessor based with true RMS sensing trip units.	☐	☐	
6.	Panelboards is installed such that the highest breaker handle is not more that 6'6" AFF	☐	☐	
7.	Typewritten directory of panelboard loads including circuit number, equipment served, and room number	☐	☐	
8.	Panelboard identification with plastic laminated nameplate (white with black lettering) mounted to panel with screws. Nametag to indicate panel name, amperage, voltage, phase and panel fed from.	☐	☐	
9.	Verify equipment is clean and free from damage	☐	☐	
10.	Verify Panelboard is size and voltage as specified in contract documents, including breaker quantities and sizes.	☐	☐	
11.	Verify panelboard is installed to provide all working space requirements and clearances per NEC and local codes.	☐	☐	
12.	Verify that no piping, ductwork, or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to the panel and extending additional 6" on either side.	☐	☐	
13.	Panelboards that are part of the emergency distribution system is installed in space fully protected by an approved automatic fire suppression system or installed in space with a (1) one hour fire rating.	☐	☐	

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Manufacturer Representative			
Construction Administrator			
Commissioning Agent			

Sample Functional Performance Test

Switchboard MDP

1. Participants

Name/Representing		Participation (Testing, Witness, etc)
/		
/		
/		

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

(Y/N) Factory testing results by the switchboard manufacturer have been provided for testing the ground fault protection system for circuit testing and verification of the tripping of the ground fault relays and also include polarity verification of the interconnection of the ground fault sensor circuits.

(Y/N) Field test reports have been provided for switchboard start up and testing and includes test procedure used and test results that comply with testing requirements. Included with the electrical contractors field start up and installation testing for the switchboard verify the ground fault protection system has been field tested and the test result have been provided.

(Y/N) A short circuit and protection coordination study has been provided and the switchboard protective relays and breakers settings have been adjusted per the study recommendations.

(Y/N) The electrical contractor has certified that their internal commissioning is complete and the project is ready for third-party verification. EC initials: _ _. Date: _ _.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _ _. Date: _ _.

5. Notes

6. Functional Testing Record :
Perform a visual verification of installed Switchboard # MDP

Seq. ID	Switchboard Location	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1		Verify switchboard is installed on 4" concrete pad.)	Concrete curb installed	Y / N	

Seq. ID	Switchboard Location	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
2.		. Verify operation of digital metering monitor: view the following : 1. Phase currents (each phase) 2. Ph-PH voltages (3ph) 3. Ph-Neutral voltages (3ph) 4. Frequency	All values indicated on monitor display screen.	Y / N	
3.		Verify Switchboard identifications, all switchboard compartments to have nameplate identifications.	Nameplates installed	Y / N	
4		Operate selective circuit breakers and verify correct operations	Circuits breaker operated open/closed	Y / N	
5		Verify circuit breaker with adjustable trip units are adjusted per the coordination study results (compare with study results)	Circuit breaker trip units match study.	Y / N	
6		Verify switchboard is installed with quantity and sizes of breakers as indicated in the contract documents.,	Circuit breakers installed per design.	Y / N	

-- END OF TEST --

END OF SECTION 260800

270000

TECHNOLOGY
(Sub-Sub Bid Required)

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END OF INDEX

SECTION 270000

TECHNOLOGY
(Sub-Sub Bid Required)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

B. Examine all other Sections of the Specifications for requirements that affect work of this Section whether or not such work is specifically mentioned in this Section.

C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 TIME, MANNER AND REQUIREMENTS FOR FILING SUB-SUB-BIDS

A. FILED SUB-SUB-BID REQUIRING A PARAGRAPH “E” LISTING on the FORM FOR SUB-BID required per M.G.L. Chapter 149 Section 44A to 44L, as amended to date. The Electrical Subcontractor will be responsible for all related building preparation and coordination as required, see specification for additional Paragraph “E” Listing requirements of the Listed Systems Contractor, and coordination of responsibilities.

B. Section 270000 COMMUNICATIONS shall be a Filed Sub-Sub Bid of Section 260000 ELECTRICAL, requiring a Paragraph “E” Listing on the FORM FOR SUB-BID

C. This Section shall be provided by a qualified Systems Contractor.

D. The Systems Contractor shall be DCAM Certified by the state of Massachusetts Division of Capital Asset Management, in the category of: TELECOMMUNICATIONS SYSTEMS.

1.3 QUALITY ASSURANCE

A. Sustainable Goals: The Architect has designed the project to meet the Owner’s sustainable goals. Products and systems have been specified which meet certain third-party evaluations or have particular VOC and source requirements. Evaluation of products proposed for substitution will be evaluated based on the Owner’s sustainable goals and other criteria included in Division
   1. The Contractor is encouraged to use sustainable construction practices, means and methods. Unless specifically stated in a specification section, no sustainable design documentation is required of the Contractor.

1.4 COOPERATION AND COORDINATION WITH OTHER TRADES

A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.

B. This Section shall be furnish/installed as follows by a single firm/company that is a qualified systems contractor. The Electrical Subcontractor shall be responsible for properly preparing the project for installation by systems contractor, as specified.

C. Electrical Subcontractor responsibilities shall include: The Electrical Subcontractor shall be responsible for furnishing and installing all related building preparation including, but not limited to: outlet boxes with plaster rings, floor boxes, poke through devices, pathways, power, cableways, cable tray, cable protection, wiremold, surface raceways, cable supports, conduits with bushings, conduit stubs with bushings, sleeves with bushings (all conduits, stubs, sleeves, J-Hooks, etc. shall be brought to an accessible ceiling or accessible area below floor), pull strings, bonding, grounding, core drilling, cutting, patching, fireproofing of penetration & openings, environmental seals, smoke and fire stopping seals including all conduits, raceways, sleeves, slots etc. where cables pass from one location to another, seismic supports, supplementary steel and channels, etc., for a completely operational system, as specified. The Electrical Contractor is responsible for installing all required sleeves for a complete installation whether they are shown or not on the floor plans the routing of cables is determined by the Architecture and no Ethernet cable can exceed 90m or max distance rating of CAT6 cable use. The Electrical Subcontractor shall also accept delivery and properly store & secure all equipment and materials required by the systems contractor. The Electrical Subcontractor shall install all specialized backboxes (microphone, amplifier, etc.) and any exterior antennas furnished by Systems Contractor.
   1. The Electrical Subcontractor shall provide cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and to secure the top of the racks to the structure. Cables shall drop straight down to equipment racks. Cable trays shall be secured at both ends to the structure and connected together as required for a complete contiguous installation. Utilize proper supports to support the cable tray to the building structure as well as the equipment rack and cabinet. Submit mounting supports for approval before installation.
   2. The Electrical Subcontractor shall provide 120VAC duplex 20amp dedicated circuits twist lock 20amp dedicated circuit in cable tray over each rack, and 208VAC twistlock 20amp over each server cabinet in the system as shown on drawings.
   3. This entire Section: The Electrical Subcontractor shall read this section in its entirety and shall provide all requirements of the Electrical Subcontractor as detailed in this Section.

D. Systems Contractor responsibilities for this section shall be: Systems contractor shall be responsible for providing, installing, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment specified in this section for a completely operational system. The systems contractor shall furnish all specialized backboxes (speaker, microphone, amplifier, etc.) and all exterior antennas to the Electrical Subcontractor for their installation.
   1. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work. The electrical subcontractor shall furnish and set in place all sleeves, pockets, supports and incidentals.
   2. All distribution systems which require pitch or slope such as plumbing drains, steam and condensate piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, ducts, lights and apparatus and install work to avoid interferences.

3. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interferences or to provide adequate clearances for Code and maintenance requirements shall be made at no additional costs.
4. Structural elements of the project shall not be relocated, altered or changed to accommodate the work without written authorization from the Architect.
5. Work that is installed before coordination with other trades or that causes interference with the work of other trades shall be changed to correct condition.
6. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.
7. Attend project coordination meetings to coordinate work of this Section, work of other trades and project and phasing requirements.

1.5 SUBMITTALS

A. Product Data for all materials specified and shown on drawings to be installed.

B. Equipment List: Provide a detailed Equipment List showing quantities by manufacturer and model number of all major items of equipment and installation material to be used in the system as specified herein.

C. Submit supporting hardware for this system as part of the work for approval prior to installation.

D. Product Data: Include complete sets of indexed cut sheets, in quantity as dictated by the project, of all major pieces of equipment and materials being supplied. Arrange these sheets in the order the equipment appears in the Specification. Clearly highlight information showing compliance with this and/or all applicable Specifications. In the event that the manufacturer or representatives' cut sheet contains more than one item, clearly indicate which items of the cut sheet are intended for installation.

E. Shop Drawings: Submit a set of complete Shop Drawings, by system, showing equipment to be installed. Include system configuration block diagrams of all equipment, indicating equipment type and model numbers. Show each and every component, system and subsystem, as well as all proposed connections between system components, and proposed layouts of equipment racks for the entire system.

F. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

G. Cabling administration drawings and printouts.

H. Wiring diagrams to show typical wiring schematics including the cross-connects.

I. Cross-connects. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

J. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.

K. Cable tray layout showing cable tray route to scale with relationship between the tray and adjacent structural, electrical and mechanical elements.

L. Quality Assurance Submittals:
1. Provide manufacturer's certification that Installer is qualified to install systems specified. Include a written statement signed by the Installer attesting that they have been in business for at least five years in the installation and servicing of systems specified. Include the names of at least five clients for whom similar Work as specified has been performed in the past three years; list the individual responsible for the day-to-day operation of the system along with their current telephone number and address.
2. Provide names, qualifications, and certifications of installation personnel including Communication Systems Installer's site Supervisor/Foreman who shall be in charge of, and responsible for, all activities at the job site for the duration of the Project. The job Supervisor/Foreman shall not be changed during the project without notification and approval from the Owner.
3. Complete warranty information including sample Registration Certificate.

M. Technical Diagrams and Drawings:
1. Simplified single line block diagrams showing the interconnection of all equipment and functional relationships. Show all equipment, patch panels, cables and jacks, whether connected or not. The intent of these diagrams is to provide sufficient clear and complete information that a technician of average skill may efficiently troubleshoot and service the system, even if unfamiliar with the installation.
2. Provide "As Built" architectural quality plan Drawings at 1/8" = 1'-0" scale. Provide an electronic copy of the "As Built" drawings on CD(s).
3. All technical diagrams and drawings shall be mounted on the wall behind a clear plastic cover for protection. There shall be 1 set of the above drawings and diagrams provided per equipment room, this includes both the MDF Room and all IDFs.

1.6 TELEPHONE/DATA SYSTEM

A. General:

B. All telecommunication and data system interconnecting wiring, terminal blocks, connections, terminations, shall be furnished and installed by a licensed and certified installer.

C. The Electrical Subcontractor (E.C.) shall furnish and install all raceways, and outlet boxes as indicated on the drawings, including pull wires for all empty raceways and all access panels. General contractor will furnish and install all backboards (3/4" thick by 78" high) which shall be mounted at the MDF room and each IDF room.

D. General Requirements:
1. Applicable Standards:
a. Materials and equipment shall be installed in accordance with the most current versions of the National Electrical Code, local codes, safety codes, ANSI, ASTM, EIA, TIA, BISCI, IEEE, UL, NFPA.
1) The following industry standards are the basis for the structured cabling system described in this document.
- ANSI/TIA/EIA
- TIA/EIA-568-B Commercial Building Telecommunications Cabling Standard
- TIA/EIA-568-B.1 General Requirements
- TIA/EIA-568-B.2 Balanced Twisted Pair Cabling Components Standard
- TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard

- TIA/EIA - 942 Telecommunications Infrastructure for Data Centers
- TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathway and Spaces
- TIA/EIA-606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- J-STD-607-A Commercial Building Grounding/Bonding Requirements NFPA
- NFPA 70 National Electric Code (NEC) ISO/IEC
- ISO 11801 Generic Cabling for Customer Premises
- EIA/TIA-TSB 67. Telecommunications Systems Bulletin, Additional Transmission Specifications for Unshielded Twisted-Pair Cabling Systems"
- EIA/TIA-455-61. "FOTP-61, Measurement of Fiber or Cable Attenuation Using An OTDR".
- IEEE 802.3 "Carrier Sense Multiple Access With Collision Detection".
- ATM Forum Standard for 155 Mb/s ATM over Category 6 (AF-PHY-0015.000, 9/94)
- BISCI: Telecommunications Distribution Methods and LAN Design Manual
- IEEE-802: Standards for Local Area Networking
- UL Performance Levels Certification Program
- ANSI-IEEE-C2: National Electrical Safety Code (NESC)
- ANSI/NFPA-101: Life Safety Code
- Massachusetts Electric Code CMR527

2. Exposed wiring is not acceptable in any occupied space.
3. Contractor is responsible for strict adherence to Massachusetts electrical codes, and all other applicable codes.
4. The contractor is responsible for obtaining municipal permits and inspections as mandated by law.
5. All exposed cabling shall be run in raceway or conduit.
6. All penetrations in station raceway shall have rubber or equivalent grommets to prevent cable cuts on trough edges.
7. Raceway shall be of sufficient size to accommodate all wiring. Fill density not to exceed 40%, unless otherwise noted. It is the responsibility of the bidder to determine the size needed based upon the floor plans provided. A minimum size of ¾" conduit shall be adhered to.
8. All raceways shall be attached to the building structure using screws and anchors.
9. The I.T. sub contractor is responsible for all aspects of MDF & IDF construction. Refer to drawings for configuration of each IDF and MDF.
10. All cabling at the MDF and IDFs shall be neatly bundled and dressed to the termination blocks. All appropriate cable management materials (slotted duct, D rings, etc.) should be utilized for this purpose. All wiring at IDF cabinets shall be installed concealed.
11. All labeling of cables shall be 6" back from the termination with machine generated labels, hand written labels are not permitted.
12. All cable pulls in conduit, raceway, innerduct, etc. shall have pull string left in place for future use.
13. Color code identification of cables must be maintained throughout all splices.
14. All station cabling shall be clearly and legibly labeled at both the faceplate end and the IDF/MDF termination blocks. In addition to labeling both the inside of the faceplates and IDF/MDF termination blocks, the cable jacket shall be labeled six inches back from the terminations on both ends. Labeling shall be machine generated.

15. Labeling of the outside of the jack with identification numbers shall be made using a Panduit LS8 handheld label machine or equal. Samples shall be provided to Engineer for approval prior to installation.
16. In order to qualify for installation of the data communications system, Contractor must possess the required license classification, a performance history, experience in the installation and termination of optical fiber cable systems, and proof of time in business. Contractor must be trained and certified for the communications cable and hardware which it installs, and must furnish proof of certification.
17. License Classification: Contractor must posses a valid state Contractor's License.

E. Unless otherwise indicated, the following work is not included as part of the systems integrator's responsibilities in this SECTION, except for coordination, and is to be performed by others as indicated:

F. Raceway shall be provided by the electrical contractor.

G. Empty conduits to accessible point above ceiling or below floor shall be provided by the electrical contractor.

H. Floor boxes and poke through devices shall be provided by the electrical contractor.

I. Standard device boxes with plaster rings for data and Integrated Instructional Technology Network System shall be provided by the electrical contractor.

J. Clock system backboxes and custom pigtails shall be installed by the electrical contractor and provided by this systems integrator. 120V wiring by Electrical Contractor.

K. Speaker/paging system backboxes shall be installed by the electrical contractor and provided by this systems integrator.

L. Structural blocking to support wall and ceiling mounted televisions/monitors shall be provided by the General Contractor.

M. Interface with public utilities telephone service shall be arranged by the owner, and coordinated with this systems integrator.

N. Telephone equipment and handsets will be provided under a separate contract.

1.7 DEFINITIONS

A. Main Cross Connect (MC): The MC is the location, within a building or complex of buildings, where the entire telecommunications system originates. It may include: the physical location, enclosure, wire and cable management hardware, termination hardware, distribution hardware, and patching and equipment racks.

B. Horizontal Cross Connect (HC): The HC is the location in a building where a transition between the backbone or vertical riser system and the horizontal distribution system occurs.

1.8 SYSTEM DESCRIPTION

A. The data communications system shall consist of four components, active switch equipment, an optical fiber backbone, a copper twisted-pair backbone, and twisted pair copper work station cabling.

B. The audio visual systems shall consist of wiring, jacks, amplification equipment, control equipment, and head end video equipment.

1.9 SCOPE OF WORK

A. The work under this Section includes providing of all material, labor, equipment and supplies and the performance of all operations to provide a complete working Integrated Instructional Technology Network System as required by the Drawings and details and as specified herein. Where the Drawings, Specifications, Codes, Regulations, Laws, or the requirements of the local Authority conflict, provide the higher quality and higher quantity indicated or required and follow the strictest requirement. In general, the work includes, but is not limited to, the following:

B. Cabling for Sound and Clock per manufacturers requirements.

C. Equipment Racks and Cabinets.

D. Relay Brackets.

E. Terminations.

F. Protection of all work.

G. Record Drawings and Documentation.

H. Staging.

I. Telephone and data cabling.

J. Data network racks and patch panels

K. Network fiber optic back bone cabling

L. Phasing for telephone/data/paging to keep occupied areas of the building operational.

M. Operation and Maintenance Instructions and Manuals for the Section's work.

N. Nameplates, Labels and Tags.

O. Testing and certification.

P. Coordination with manufacturers, other trades and Owner.

Q. CATV wiring, amps and splitters.

R. Sound, Public Address, Master Clock and Intercom.
1. Integrated Sound, System Computer and Software.
2. Classroom/Staff/Administrative Telephone System Outlets.
3. Telephone System Integration Requirements.
4. Ceiling / Wall Mounted Speaker Assemblies.
5. Bell/Class Change Signaling System.
6. Public Address System.
7. Controls, Amplifiers, and Terminal Equipment.
8. Power Supplies.

9. Battery Backup for System Programming.
10. Program Distribution System.
11. Wireless Master Clock System.
12. Wireless Secondary Clocks.
13. Accessories.
14. Local sound system interface with paging system.

S. Provide and maintain in safe adequate condition all staging and scaffolding required for the proper execution of the work of this Section.

T. Coordinate work with that of all other trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.10 PROTECTION OF WORK AND PROPERTY

A. Be responsible for the care and protection of all work included under this Section until it has been tested and accepted.

B. Protect all equipment and materials from damage from all causes including theft. All materials and equipment damaged or stolen shall be replaced with equal material or equipment at the option of the Architect and Owner.

C. Materials and equipment stored for this project shall be protected and maintained according to the manufacturer's recommendations and requirements and according to the applicable requirements of NFPA 70B.

D. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen and make good any damage caused.

E. Use caution to avoid damage to existing work, and to prevent harm to personnel working in all areas.

F. Observe all safety precautions and requirements for the construction.

G. When open-flame or spark producing tools such as blower torches, welding equipment, etc., are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where the work is to be performed. Provide, where necessary, fire protective covering and maintain a constant non-working fire watch where work is being performed and until it is completed.

H. The General Contractor and the Installer are responsible for initiating, maintaining, and supervising all safety precautions and requirements during construction.

1.11 SEQUENCING AND SCHEDULING

A. Coordinate the work of this Section with the respective trades responsible for installing interface work, and ensure that the work performed hereunder is acceptable to such trades for the installation of their work.

B. Continuity of all services shall be maintained in all areas which will be occupied or temporarily relocated during the construction period. If an interruption of service becomes necessary, such shall be scheduled in advance, made only upon consent of the Owner and at a time outside normal working hours as the Owner shall designate.

C. Refer to the overall scheduling of the work of the project. Schedule work, process Submittal and order materials and equipment to conform to this schedule and install work to not delay nor interfere with the progress of the project.

D. Inform Architect immediately of any delays or potential delays. Furnish manufacturer's letter to verify order date, equipment delays, expected shipment date, order number, and potential remedies to speed up delivery. Any costs to speed up delivery shall be implemented at no cost to the project if the equipment or material was not ordered as soon as possible after Contract award or within the time frames indicated with the Submittal.

E. Include premium time required to comply with the project scheduling and phasing.

F. Be aware of, and plan for, project scheduling and phasing. Provide for complete continuous operation of all systems. Coordinate scheduling and phasing with the Architect, Owner, other Trades, and the General Contractor.

1.12 WARRANTY

A. Voice and Data Cabling Warranty: The products that shall best support the needs of the project, and provide the highest level of system performance over the life of the facility, shall be a voice and data cabling system that is made up of system components designed, manufactured and installed as a total system solution. This requirement also applies to data patch cords specified in this Section; e.g. Ortronics patch cords shall be used with Ortronics jacks and patch panels.

B. Provide a Manufacturer's Extended Product Warranty that covers product defects for all passive components of the Voice and Data Cabling System. Passive components are defined as those exhibiting no gain or contributing no energy to the Data Cabling System and include but are not limited to cabling, connectors, outlets, patch panels, patch cords, racks as outlined in PART 2 of this Specification.

C. The following shall be covered by the Manufacturer's Extended Product Warranty:
   1. All passive components that comprise the Voice and Data Cabling System will be free from manufacturing defects in material of workmanship under normal and proper use.
   2. All passive components that comprise the Voice and Data Cabling System shall exceed the specifications of ANSI/TIA/EIA 568B series, and exceed ISO/IEC 11801 standards, including all subsequent changes to these standards that are in effect at the time of bidding, and shall meet or exceed the performance specifications as outlined in PART 2 of this Specification.
   3. The installation shall exceed the insertion and return loss, attenuation and near end crosstalk (NEXT) requirements of ANSI/TIA/EIA 568B series and the ISO/IEC 11801 standards for cabling links/channel configurations specified in these standards including all subsequent changes to these standards that are in effect at the time of bidding.
   4. Each Voice and Data Channel shall be capable of delivering data at 1.2 Gbps between active network electronics. A Data Channel is comprised of all passive components including cabling, connectors, patch panel port, and patch cords, with up to a total of 4 connections between Owner's network electronics (not in the contract).

D. Upon successful completion of the Voice and Data Cabling System installation by the Communication Systems Installer, and subsequent inspection by an authorized representative of the Manufacturer of the passive components, the Owner shall be provided with Registration Certificate, from the Manufacturer, registering the Installation.

E. Duration of Warranty: The warranty shall run for 20 years from the Date of Substantial Completion of the Project, unless the Registration Certificate is issued by the Manufacturer at a later date, in which case the warranty shall run for 20 years from the date that the Registration Certificate is issued.

F. The Extended Product Warranty is applicable to the Voice and Data Cabling System passive components at the original site of installation. Under the Extended Product Warranty, the Manufacturer of the passive components shall either repair or replace the defective product(s) at the Manufacturers cost. This includes the replacement or repair cost of defective materials and the cost of labor to repair or replace any and all defective products.

G. The Communication Systems Installer shall be able to provide a Manufacturer's warranty that the Voice and Data Cabling System shall be free from failures which prevent operation of the specific applications for which the original Voice and Data Cabling System was designed to support, including but not limited to: 10Base-T; 100Base-T; 52/155 Mbps ATM; 622Mbps 64-CAP ATM; 1000Base-T Gigabit Ethernet.

1.13 MAINTENANCE

A. Provide installers maintenance contract quote, upon request, for a period equal to warranty.

B. Upon receipt of notice from the Owner of failure of any part of the systems during the warranty period, the affected parts shall be replaced. Any equipment requiring excessive service consisting of more than two unscheduled service calls, shall be considered defective and shall be replaced.

C. Response times to warranty issues shall differ according to the level of the problem.

D. A problem is considered to be corrected when the system and its components operate according to specified requirements.

E. Warranty work shall be performed according to the procedures of the Owner, its staff and tenants and their normal operations.

1.14 SEISMIC REQUIREMENTS

A. Equipment and work shall meet the restraint requirements for a Seismic Zone - 2 location including installation and connections of material and equipment to the building structure.

1.15 FUNCTION AND OPERATION

A. The intended function of the data communications cable system is to transmit data signals from a central location to several individual data outlet locations. Upon completion of the work outlined in this specification, the system shall be capable of transmitting data signals at a rate of 1000 Mbps.

B. The multimode optical fiber cable system shall be capable of transmitting signals with a minimum bandwidth of 160 MHz at both 850 or 1300 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable, shall be less than 10 dB. The singlemode optical fiber cable system shall be capable of transmitting signals with a bandwidth of up to 500 MHz at both 1300 and 1550 nm. The cumulative signal loss, through connectors, jumpers, couplers, and fiber cable, shall be less than 10 dB.

C. Work station cable, from the HC to the work area, shall be installed in accordance with EIA/TIA-568-A specified installation practices, EIA/TIA TSB 67 recommended installation practices, manufacturer specified installation practices, and shall be capable of transmitting a signal at 1000 Mbps with acceptable attenuation and cross-talk measurements. The entire work station cable system, including wiring blocks, cable, and telecommunications outlets shall be tested for Category 6 compliance.

1.16 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Connecting Blocks: One of each type.

C. UTP 4-pair Station Cable: 1,000 feet.

D. UTP Backbone Cable: 300 feet.

E. Patch-Panel Units: One of each type.

F. Device Plate: 10 of each type.

PART 2 - PRODUCTS

2.1 GENERAL

A. Throughout Part 2, material quantities are given. These quantities are given for reference purposes only. It is the responsibility of the Contractor to provide appropriate quantities of materials to provide a complete, functional system.

B. Equipment shall be installed in accordance with Technology drawings. General installation provisions are as follows:
   1. Equipment Racks: Equipment racks shall be assembled and mounted in locations shown in the Drawings and as described herein. Each rack shall be assembled in accordance with the manufacturer's instructions and recommendations. Each rack shall be mounted such that the side rails are plumb. Each rack shall be affixed to the building structure at each of the mounting holes provided. Attachment shall be by 1/2" X 1-1/4" lag bolts. A 3/8" pilot hole shall be drilled for each lag bolt. Each bolt shall be tightened to the extent that it holds the mounting hardware firmly, but not so tight as to distort the hardware or strip the threads. Equipment racks are to be co-located with the quadplex power outlets to allow for easy connection of racked equipment to the power system of the school.

2. Wiring Blocks and Wire Management Components: Where required, wiring blocks and wire management components shall be mounted to the plywood backboard. Wiring blocks and wire management shall be mounted in accordance with the attached drawings. Each device shall be mounted such that its horizontal dimension is level. In cases where more than one device is mounted, they shall be aligned vertically. Each device shall be affixed to the plywood backboard by means of screws suitable for fastening to plywood. A minimum of four (4) of the mounting holes provided shall be utilized for fastening. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage the device. Wiring blocks shall be terminated in accordance with the manufacturer's instructions and recommendations. Installation of accessories shall also be conducted in accordance with the manufacturer's instructions and recommendations.

2.2 COMMUNICATION EQUIPMENT ROOM FITTINGS

A. Summary

Section Includes:
1. Telecommunications mounting elements.
2. Pathways
3. Telecommunications equipment racks and cabinets
4. Grounding.

B. Coordination: Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
5. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

C. Pathways
1. General Requirements: Comply with TIA/EIA-569-A.
2. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.
   a. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
   b. Support brackets with cable tie slots for fastening cable ties to brackets.
   c. Lacing bars, spools, J-hooks, and D-rings.
   d. Straps and other devices.

D. Equipment Frames (Racks)
   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. APC
      b. Cooper B-Line, Inc.
      c. Hubbell Premise Wiring.
      d. Panduit
   2. General Frame Requirements:
      a. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
      b. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
      c. Finish: Manufacturer's standard, baked-polyester powder coat.
   3. Floor-Mounted Racks: Modular-type, four-post quick rail, aluminum construction.
      a. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and (2) power strips.
      b. Baked-polyester powder coat finish.
   4. Equipment Cabinets:
      a. 42RU, 24” W x 42” D.
      b. Steel construction.
      c. Treated to resist corrosion.
      d. Perforated front and rear doors.
      e. Lockable front and rear doors.
      f. Louvered side panels.
      g. Cable access provisions top and bottom.
      h. Grounding lug.
      i. Rack-mounted, 250-cfm fan.
      j. 19” Dual slide rack mount monitor keyboard drawer (provide 2)
      k. Power strip (2).
      l. All cabinets keyed alike.
      m. Regulatory approvals: EIA-310-D
      n. Warranty: 5-years
      o. Standards: UL 60950
   5. Cable Management for Equipment Frames:
      a. Metal, with integral wire retaining fingers.
      b. Baked-polyester powder coat finish.
      c. Vertical cable management panels shall have front and rear channels, with covers.
      d. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.
   6. Power Strips: Comply with UL 1363.
      a. Rack mounting.
      b. Receptacles: Six 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles for each power strip. Provide two in each rack.
      c. LED indicator lights for power and protection status.
      d. LED indicator lights for reverse polarity and open outlet ground.
      e. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
      f. Cord connected with 15-foot line cord.
      g. Rocker-type on-off switch, illuminated when in on position.
      h. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
      i. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all 3 modes shall be not more than 330 V.

E. Grounding
1. Comply with requirements in 260000 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.
2. Telecommunications Main Bus Bar:
a. Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
b. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
c. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.
d. Comply with ANSI-J-STD-607-A.

F. Labeling
1. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.3 FIBER OPTIC CABLE:

A. Fiber: The following cable specifications shall also be met by the cable manufacturer for fiber optic cable:
1. Multimode Optical Fiber Cabling: Multimode optical fiber cables shall meet all of the requirements delineated within the specifications of ANSI/TIA/EIA-568-B1, B2, B3 and ISO/IEC 11801, 50/125 fiber shall be as noted in Table 1 and 2. Fiber shall be laser optimized type OM3.

Table 1
Minimum Performance Parameters for LightSystem™ Cables Containing 50/125 Multimode Fiber

Fiber	Maximum Attenuation (dB		Minimum Bandwidth (MH		Guaranteed Transr Distance (m)	
	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm
50/125	3.5	1.0	200	500	275	550

TABLE 2
Minimum Performance Parameters for LightSystem PlusTM Cables Containing 50/125 or Multimode Fiber

Fiber	Maximum Attenuation (dB		Minimum Bandwidth (MH		Guaranteed Transr Distance (m)	
	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm	@ 850 nm	@ 1300 nm
50/125	3.5	1.0	220	1000	300	550

Singlemode Optical Fiber Cable:
Singlemode mode LightSystemTMal fiber cables shall meet all of the requirements delineated within the specifications as listed in section 1 except that the attenuation and zero dispersion limits shall be as noted in Table 3 and 4.

TABLE 3
Minimum Performance Parameters for LightSystem™ Cables Containing Singlemode Fiber

Fiber	Cable Type	Maximum Attenuation (dB/k		Zero Dispersion	
		@ 1310 nm	@ 1550 nm	Wavelength (nm)	Slope (nm2-km)
Singlemode	Inside Plant	1.0	1.0	1300-1324	< 0.093
	Outside Plant	0.5	0.5		

TABLE 4
Minimum Performance Parameters for LightSystem PlusTM Cables Containing Singlemode Fiber

Fiber	Cable Type	Maximum Attenuation (dB/k		Zero Dispersion	
		@ 1310 nm	@ 1550 nm	Wavelength (nm)	Slope (nm2-km)
Singlemode	Inside Plant	0.5	0.5	1300-1320	< 0.092
	Outside Plant	0.4	0.3		

2. Attenuation:
   The LightSystem™ cable as noted in Tables 1 and 3 and LightSystem PlusTM as noted in Tables 2 and 4 cable shall perform in accordance with the attenuation limits when tested per ANSI/EIA/TIA-455-46, -53, -61 or -78 (as applicable).
3. Bandwidth:
   LightSystem™ as noted in Table 1 cable and LightSystem PlusTM cable as noted in Table 2 shall perform in accordance with the bandwidth limits when tested per ANSI/EIA/TIA-455-51 or ISO/IEC 793-1-C2A
4. Transmission distance:
   The protocol pertinent to the transmission distance noted in Table 1 for LightSystem™ and Table 2 for LightSystem PlusTM cable is Gigabit Ethernet per IEEE 802.3z.
5. Zero Dispersion Wavelength and Slope:
   LightSystem™ cable shall perform as noted in Table 3 and LightSystem Plus™ cable as noted in Table 4 in accordance with the Zero Dispersion wavelength and slope limits when tested per ANSI/EIA/TIA-455-168, -169, or -175 (as applicable).
6. Fiber 50/125 μm Multimode Optical fiber cables shall be manufactured by one of the following:
   Belden
   Berk-Tek
   Commscope
   General Cable
   Mohawk
   Or equal
   Be a minimum of twelve strands of 50/125 μm multimode optical fiber for horizontal cabling.
   Be appropriate for the environment in which it is installed.
7. Fiber equipment cords shall:
   Be available in standard lengths of 1, 3, and 5 meters, custom lengths shall also be available, and shall meet or exceed standards as defined in ANSI/TIA/EIA-568-A and ISO/IEC 11801.
   Utilize duplex fiber cable that is 50/125 micron multimode, OFNR riser grade, and meets the requirements of UL 1666.
   Utilize cable where the attenuation shall not exceed 3.5 dB/km @ 850 nm wavelength or 1.0 dB/km @ 1300 nm.

Have a cable jacket color for 50/125 in gray.
The connectors shall be SC or ST in accordance with TIA/EIA-568-A and must include a ceramic ferrule.
Have ST connectors with a metal coupling nut.
Have a minimum return loss of 20 dB (25 dB typical) at both 850 nm & 1300 nm.
Be made by an ISO 9001 and 14001 Certified Manufacturer.
Be UL 1666 approved.
Siemon Company FJ Series Fiber Jumpers Recommended Category 6:

8. Coordinate fiber patch cords with Owner prior to release. Provide SC to LC, ST to LC, or any combination of the two. Provide one per fiber port.
9. Warning Tags: At each location where the fiber cable is exposed to human intrusion, it shall be marked with warning tags. These tags shall be yellow or orange in color, and shall contain the warning: "CAUTION FIBER OPTIC CABLE". The text shall be permanent, black, block characters, and at least 3/16" high. A warning tag shall be permanently affixed to each exposed cable or bundle of cables, at intervals of not more than five (5) feet. Any section of exposed cable which is less than five (5) feet in length shall have at least one warning tag affixed to it.
10. T-Bar Suspended Ceilings: Copper station cabling may be run outside of conduits and above T-Bar suspended ceilings when available, at the option of the installer. Cables installed in this fashion are to be run horizontally in bundles and tied down neatly, well clear of any light fixtures or other electrical appliances that may affect data transmissions.

B. Optical fiber Interconnect Equipment: Interconnect equipment may be mounted either on the plywood backboard or in the equipment racks, depending on the particular application. When mounted on the backboard, the horizontal dimension shall be level. A minimum of four (4) of the mounting holes provided shall be utilized for fastening. Screws shall be tightened to the extent that they hold the device snug to the backboard, but not so tight as to distort or damage the device. Interconnect equipment mounted in racks shall be affixed to the rack by at least four (4) screws. The screws shall be of the correct size and thread configuration for the holes in the rack. They shall be tightened to the extent that they hold the equipment firmly to the rack, without distorting the equipment or stripping the threads. All optical fiber interconnect devices shall be assembled and installed in accordance with the manufacturer's instructions and recommendations. All large openings into wall mounted cabinets shall be covered by a grommet.

2.4 UTP CABLE (BACKBONE)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Belden CDT Inc.; Electronics Division.
2. CommScope
3. Mohawk; a division of Belden CDT.
4. Molex
5. Superior Essex Inc.

B. Description: Multi-pair Backbone Cable: Category 5e, 100-ohm, 25-pair UTP binder groups covered with a gray thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
   a. Communications: Type CMP, complying with NFPA 262.

C. Multi-pair backbone cables: Provide copper backbone cable that meets or exceeds the following specifications:

1. Electrical Specifications:

Maximum DC Resistance	28.6 Ω/1,000 ft (9.4 Ω/100m)
Maximum DC Resistance Unbalanced	5%
Maximum Capacitance Unbalanced (pair to ground)	1,000 pF/1000 ft. (328 pF/m)
Mutual Capacitance @ 1kHz	18 nF/1000 ft (5.9 nF/100 m), ma

2. Attenuation (dB/100 m [328 ft.]):

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
4.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

3. Worst Pair Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Pair-To-Pair NEXT (Max.)
1.0 MHz	13.8 dB
4.0 MHz	11.2 dB
10.0 MHz	10.2 dB
16.0 MHz	9.2 dB

2.5 FIBER INNERDUCT

A. Description: From the MDF to each IDF, segments of optical fiber innerduct shall be installed.
   1. Quantities Required: Innerduct runs do not have to be continuous throughout, breaks are expected at the pull boxes. Contractor is responsible for determination of actual lengths of innerduct required. Enough innerduct shall be provided and installed to extend from the fiber service loop in the MDF to the fiber service loop in each IDF. If the route passes through a pull box, the segments of innerduct shall extend twelve inches into the pull box. If the route passes through an enroute HC, each segment of innerduct shall extend at least twelve inches beyond the end of the service conduit.

B. Installation: Fiber innerduct shall be installed in accordance with manufacturer's instructions and industry standards. Within the equipment rooms, the innerduct shall extend from the end of conduit to four (4) feet above the floor and shall be affixed to the backboard by means of clamps designed for that purpose. Care shall be taken to avoid kinking the innerduct or applying excessive tension during the installation process.

2.6 FIBER DISTRIBUTION

A. DESCRIPTION: From the MDF to each IDF a continuous segment of fiber cable shall be provided.
   1. Product: 12 strands multi-mode 50/125 UM and 6 strands single-mode 8.3/125 UM.
   2. Quantities Required: The contractor is responsible for determination of actual segment lengths. Actual quantities will be determined by the routing established by the electrical engineer.
   3. Required Accessories and Quantities:
      a. Kit of Parts: Sufficient quantities to block and buffer both ends of each cable segment.
      b. Sealant: Sealant sufficient quantities to block each end of each cable segment.

B. Installation: Installation shall be conducted following guidelines established by the product manufacturer and industry standards.
   1. Fiber Optic Cable: During installation of the optical fiber cable segments into the conduit system, special care shall be taken to avoid damage to the cable. While under pulling tension, the cable shall not be bent into a curve with a radius of less than twenty (20) times the cable diameter. Pulling tension shall not exceed manufacturer's recommended maximum tensile load. Contractor shall utilize a winch with tension control or a "break-away" link designed to break away at or below the recommended maximum tension.

C. The optical fiber cable shall be routed through the existing conduit and onto the appropriate HC backboard. Routing on the backboard shall be straight and plumb. A minimum ten (10) foot service loop shall be provided at each terminal location. Refer to Drawings for cable configuration.

2.7 WORK STATION CABLE

A. Description: From each MDF or IDF, 4-pair enhanced Category 6 cables shall be routed to each work station (data outlets). Category 6A shall be installed for wireless access node outlets per Technology Drawings.
   1. Product:
      a. Copper 4-pair UTP:
         1) UTP cables shall:
            a) Be manufactured by one of the following:
               - Hitatchi Cable Manchester
               - Berk-Tek
               - Commscope
               - General Cable
               - Mohawk
               - Or equal
               - Be 100 Ω 4-pair, category 6 cable/6A cable.
   2. Required Accessories and Quantities (Hard Wall Locations):
      a. Work Station: Panduit CFPLS** stainless steel Single Gang, Single Port Face plate. Using Panduit CMB**-X blank modules to fill unused ports. Refer to drawings for two, three, and four gang configurations. Modules shall be CJ688TP** – color to be selected by engineer.
   3. Work Area Equipment Cords: The Work Area Equipment Cords shall meet or exceed the following criteria:
      a. Modular Equipment Cords: Category 6/6A cable
   4. Category 6, modular equipment cords shall:
      a. Be round, and consist of eight insulated 24 AWG, stranded copper conductors, arranged in four color-coded twisted-pairs within a flame-retardant jacket.
      b. Be equipped with modular 8-position (RJ45 style) plugs on both ends, wired straight-through with standards compliant wiring.
   5. Use modular plugs which exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 microinches minimum of gold plating over nickel contacts.
   6. Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants.
   7. Utilize cable that exhibit power sum NEXT performance.
      a. Be available in several colors with or without color strain relief boots featuring a snagless design.
      b. Provide (1) 10 foot cord per data jack shown on drawings.
      c. Be made by an ISO 9001 and 14001 Certified Manufacturer.
      d. Electrical Specifications:

e. DC resistance per lead: 9.38 Ω / 100 m maximum.
f. Input impedance without averaging: 100 Ω + 15% from 1 to 100 MHz.
g. 100% transmission tested with laboratory grade network analyzers for proper performance up to 1000 MHz. Vendor shall guarantee cords are compatible with category 6 links/3A links.

8. UL VERIFIED (or equivalent) for TIA/EIA proposed category 6/6A electrical performance.
9. UL LISTED 1863.
10. All information outlets for 100 Ω 22-26 AWG copper cable shall:
    a. Be available in black, white, gray, ivory and light ivory.
    b. Accommodate a minimum of two 8-position / 8-conductor modular jacks.
    c. Utilize compliant pin technology 110 style insulation displacement connectors which allows the use of a 4-pair impact tool.
    d. Allow for a minimum of 200 re-terminations without signal degradation below standards compliance limit.
    e. Be constructed of high impact, flame-retardant thermoplastic.
    f. Be available in a screened version for 100 Ω ScTP cable.
    g. Be made by an ISO 9001 and 14001 Certified Manufacturer.
    h. Electrical Specifications:
    i. ANSI/TIA/EIA-568-B1, B2, B3 and ISO/IEC 11801 proposed category 6 compliant.
    j. The following requirements shall also be met (NEXT Loss and FEXT tested in both Differential and Common Mode):

Parameters	Performance	Performance @ 100 MHz *
NEXT Loss	+ 3.0 dB	43.0 dB
FEXT	+ 3.0 dB	43.0 dB **
Insertion Loss (Attenuation)	+ 40%	.24 dB
Return Loss	+ 6 dB	20 dB
LCL	40 dB (1-100 MHz)	**

B. INSTALLATION: Installation shall be conducted in accordance with guidelines established the manufacturer and industry standards. Wall Plates shall be mounted such that their vertical dimension is plumb. Each wall plate shall be labeled with its respective work station number. Each modular mounting frame shall be labeled with its respective work station number.

C. Technical Requirements: Horizontal cabling: the horizontal subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the Telecommunications room/closet. It consists of the telecommunications outlet/connector, the horizontal cables, optional consolidation point, and that portion of the cross-connect in the telecommunications room/closet serving the horizontal cable.

1. Cable Types: All UTP and fiber optic cables shall conform to the following standards:
    a. ANSI/TIA-568C.0 Generic Telecommunications Cabling for Customer Premises
    b. ANSI/TIA-568C.1 Commercial Building Telecommunications Cabling
    c. ANSI/TIA-568C.2 Balance Twisted Pair Telecommunications Cabling
    d. ANSI/TIA-568C.3 Optical Fiber Cabling and Components Standard
    e. Including all applicable addenda) and ISO/IEC 11801 (International) Generic Cabling for Customer Premises standard (latest amendment and including all applicable addenda).
    f.

Input Impedance	Bonded-Pair		Non-bonded Pair
100 ±	12	1-20 MHz	-----
100 ±	15	20-250 MHz	1-100 MHz
100 ±	20	250-350 MHz	-----

100 ±	22	350-625 MHz	100-200 MHz
100 ±	32	-----	200-625 MHz

g. Copper: The following cable specifications shall also be met by the cable manufacturer for 4-pair UTP, premium category 6 cables:

1) Attenuation: Qualified Cables shall exhibit worst case attenuation less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable attenuation performance for selected frequency points of interest is also provided.

Attenuation Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case			$\leq 1.82\sqrt{f} + .017 \cdot f + \frac{0.20}{\sqrt{f}}$	
Frequency of Interest	MHz			
	100		19.8 dB	
	200		29 dB	
	300		35.3 dB	

h. Near End Crosstalk (NEXT) Loss:

1) Qualified Cables shall exhibit worst case NEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable NEXT Loss performance for selected frequency points of interest is also provided.

NEXT Loss Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case Cable NEXT Los			$\geq 76 - 15\log(\frac{f}{0.772})$	
Frequency Pc Interest	MHz			
	100		44.3 dB	
	200		39.8 dB	
	300		37.1 dB	

i. Power Sum Near-End Crosstalk (PSNEXT) Loss:

1) Qualified Cables shall exhibit worst case PSNEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable PSNEXT Loss performance for selected frequency points of interest is also provided.

PSNEXT Loss Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case PSNEXT Loss			$\geq 74 - 15\log(\frac{f}{0.772})$	
Frequency Poir Interest	MHz			
	100		42.3 dB	
	200		37.8 dB	
	300		35.1 dB	

j. Equal Level Far-End Crosstalk (ELFEXT):

1) Qualified Cables shall exhibit worst case ELFEXT greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable ELFEXT performance for selected frequency points of interest is also provided.

ELFEXT Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case ELFEXT			$\geq 70 - 20\log(\frac{f}{0.772})$	
Frequency Points of Interest	MHz			
	100		27.8 dB	
	200		22.7 dB	
	300		18.2 dB	

k. Power Sum Equal Level Far-End Crosstalk (PSELFEXT):

1) Qualified Cables shall exhibit worst case PSELFEXT Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable PSELFEXT performance for selected frequency points of interest is also provided.

PSELFEXT Loss Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case PSELFEXT			$\geq 67 - 20\log(\frac{f}{0.772})$	
Frequency Points of Interest	MHz			
	100		24.8 dB	
	200		18.7 dB	
	300		15.2 dB	

l. Return Loss:

1) Qualified Cables shall exhibit worst case Return Loss greater than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable Return Loss performance for selected frequency points of interest is also provided.

Return Loss Limits Table						
				System 6SM		
Frequency Range				1-350 MHz		
Worst Case Return Loss				Frequency (MHz	Return Loss (dB)	
				$\leq f < 10$	21 +4·log(f)dB	
				$10 \leq f < 20$	25 dB	
				$20 \leq f \leq 300$	25 –7·log(f/20)	
Frequency Points of Interest	MHz	-				
	100			20.1 dB		
	200			18 dB		
	300			16.8 dB		

m. Propagation Delay (ANSI/TIA/EIA-568-A-1):

1) Qualified Cables shall exhibit worst case Propagation Delay less than the values derived using the equations shown in the chart below from 1 MHz to the highest referenced frequency value. Worst case qualified cable Propagation Delay performance for selected frequency points of interest is also provided.

Propagation Delay Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case Propagation Dela			$< 476 + \frac{36}{\sqrt{f_{MHz}}}$	
Frequency Poir Interest	MHz 100 200 300		480 ns 479 ns 478 ns	

n. Delay Skew (ANSI/TIA/EIA-568-A-1):

1) Qualified Cables shall exhibit worst case Delay Skew less than the values specified in the chart below per 100 m from 1 MHz to the highest referenced frequency value.

Delay Skew Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case Skew	MHz 100 200 300		25 ns 25 ns 25 ns	

o. Longitudinal Conversion Loss (LCL):

1) For all categories of 100 Ω unshielded and screened cables, the worst case calculated LCL for any pair in a 100 m cable shall not be less than 35 dB, from 1 MHz to the highest referenced frequency for each performance category. LCL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent. Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

LCL Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case Skew	MHz 100 200 300		35 dB 35 dB* 35 dB	

p. Longitudinal Transfer Conversion Loss (LCTL):

1) For all categories of 100 Ω unshielded and screened cables, the worst case calculated LCTL for any pair in a 100 m cable shall not be less than 35 dB, from 1 MHz to the highest referenced frequency for each performance category. LCTL measurements shall be performed in accordance with ITU-T Recommendation O.9 (November, 1988) or equivalent. Calculated LCL performance shall be determined by subtracting the test balun loss correction factor (as specified by the balun manufacturer) from the measured value at all frequencies.

LCTL Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case Skew	MHz			
	100		35 dB	
	200		35 dB*	
	300		35 dB*	

q. Attenuation to Crosstalk Ratio (ACR):

1) Using “pair-to-pair NEXT Loss”, all Qualified Cables shall exhibit worst case ACR performance for the specified frequency range shown in the following table.

ACR Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst Case	MHz			
	1-80		24.1 dB	
	80-100		24.1 dB	
	1-100		24.1 dB	
	100-300		.5 dB	

PSACR Limits Table				
			System 6SM	
Frequency Range			1-350 MHz	
Worst PSACR	MHz			
	1-80		22.1 dB	
	80-100		22.1 dB	
	1-100		22.1 dB	
	100-300		-1.5 dB	

r. Transfer Impedance:

1) Surface Transfer Impedance is specified for ScTP cables and is determined by the formula below in mΩ/m where f = frequency. All qualified ScTP cables shall have a margin greater than or equal to the values specified in the following table.

$$T_{cable} = 37 + 4f + 4\sqrt{f} + 5\sqrt[3]{f}$$

Transfer Impedance Limits Table			
Margin 1-100 MHz		System 6SM	
Transfer Impedance		10 %	

2.8 MAIN DISTRIBUTION FACILITY (MDF)

A. DESCRIPTION: The equipment shall be installed in accordance with Drawings.
   1. Products and Quantities:
      a. Equipment Rack: - As specified.
      b. Fiber Interconnect: Panduit FRME24 rack mount fiber optic enclosure or equal. Supply and install as many as necessary to service all fiber strands entering the MDF.
      c. Modular Patch Panels: Panduit CPPLA48WBLY or equal: 48-port patch panel wired Category 6 Patch Panel. One (1) Port for each workstation served from the MDF with a minimum of 12 spare ports are required. If the number of workstation cables, plus required spare count (12) is greater than 48, then a second 48-port patch panel is required. Supply and install as many patch panels in the MDF as necessary to service all workstation cables plus the required spare count. Provide separate CAT 6A patch panels as required for CAT 6A cables serving wireless access point outlets.
      d. Patch Cables: Panduit UTPSPXX-** or equal where XX is the length in feet and ** is the color. The length shall vary between 3' and 15' and shall be determined by Owner.
   2. Required Accessories and Quantities:
      a. Adapter Panels: Panduit FAP6WEIDSC – 6 Port Duplex Multimode SC Adapter Panels.
      b. Fiber Jumpers: Panduit F6D3-3M3Y, 3 meter, Duplex, 62.5, SC to LC Fiber and ST to LC Fiber Jumper or equal.
      c. Cable Management: Panduit WMPH2E Front/Rear cable manager or Panduit WMPLS Low Profile Cable Manager or equal.
      d. Cable Management Rings and Strain Relief: Panduit WMBV1 21"x5" Vertical Manager Ring, Panduit WMBV2 2"x5" Vertical Manager Ring and/or Panduit WMSRC1 or WMSRC2 strain relief clips. Provide and install sufficient quantities to conform to attached Drawings.

B. Installation: Installation shall be conducted in accordance with manufacturer's recommendations, industry standards, and this specification. Installation includes complete assembly and mounting of the fiber interconnect equipment, dressing the fiber and copper cables, complete assembly and mounting of the equipment rack, and mounting of the wiring blocks. Equipment shall be mounted in accordance with attached Drawings.

2.9 INTERMEDIATE DISTRIBUTION FACILITIES

A. Description: The equipment shall be installed in accordance with Drawings.
   1. Products and Quantities:
      a. Equipment Rack: - As specified.
      b. Fiber Interconnect: Panduit FRME24 rack mount fiber optic enclosure or equal. Supply and install as many as necessary to service all fiber strands entering the IDF.
      c. Modular Patch Panels: Panduit CPPLA48WBLY or equal: 48-port patch panel wired Category 6 Patch Panel. One (1) Port for each workstation served from the IDF with a minimum of 12 spare ports are required. If the number of workstation cables, plus required spare count (12) is greater than 48, then a second 48-port patch panel is required. Supply and install as many patch panels in the IDF as necessary to service all workstation cables plus the required spare count. Provide separate CAT 6A patch panels as required for CAT 6A cables serving wireless access point outlets.

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   c. Cable Management: Panduit WMPH2E Front/Rear cable manager or Panduit WMPLS Low Profile Cable Manager or equal.
   d. Cable Management Rings and Strain Relief: Panduit WMBV1 21"x5" Vertical Manager Ring, Panduit WMBV2 2"x5" Vertical Manager Ring and/or Panduit WMSRC1 or WMSRC2 strain relief clips. Provide and install sufficient quantities to conform to attached drawings.

B. Installation: Installation shall be conducted in accordance with manufacturer's recommendations, industry standards, and this specification. Installation includes complete assembly and mounting of the fiber interconnect equipment, dressing the fiber and copper cables, complete assembly and mounting of the equipment rack, and mounting of the wiring blocks. Equipment shall be mounted in accordance with Drawings.

2.10 TESTING AND DOCUMENTATION

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
   2. Visually confirm Category 6/6A marking of outlets, cover plates, outlet/connectors, and patch panels.
   3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      a. Provide test instruments that meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   5. Multi-pair Voice Riser Tests:
      a. Test each pair of multi-pair voice riser cables for proper polarity; no reversals; no transpositions; continuity; no shorts; no AC voltages; no DC voltages; no opens; and proper numbering at each termination.
      b. Bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
      c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.

6. Category 6 Data, and Voice UTP Cable Testing:
    a. Test voice and data jack in each Outlet for Category 6 ANSI/TIA/EIA 568B series compliance, using a Certified Level III testing instrument. Tests shall verify both the integrity of all conductors and correctness of the termination sequence. Tests shall also include length, mutual capacitance, characteristic impedance, attenuation and near-end and far-end crosstalk. Testing shall be performed between modular jacks at the Outlets and the modular jacks at the patch panel field.
    b. The Communication Systems Installer shall bring cables and/or pairs not meeting the requirements of the standard into full compliance, at no additional cost to the Owner.
    c. Document cable testing in accordance with Submittals Article. Provide a table of test results in a 3-ring binder submitted with the as-built Drawings.
7. Fiber Optic Cable Testing:
    a. Test all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end to end OTDR trace, or a bi-directional end to end power meter test performed per ANSI/TIA/EIA 455 53A. The system loss measurement shall be provided at 850 and 1310 nanometers.
    b. Pre-installation cable testing: Test all fiber optic cable prior to the installation of the cable. Assume all liability for the replacement of the cable should it be found defective after the installation.
    c. Loss Budget: Fiber links shall have a Maximum Loss of:
    d. Maximum Loss = (allowable loss per km) (km of fiber in link) + (.4dB)(number of connectors) Note: A mated connector-to-connector interface is defined as a Single connector.
    e. Loss numbers for the installed link shall be calculated by taking the sum of the bi-directional measurements and dividing that sum by two. Any link not meeting the requirements of the Maximum Loss shall be brought into compliance at no additional charge to the Owner.
    f. Prepare a certification report listing the test results and both the calculated and measure loss for each fiber. Submit this report with the test results as called for in the Submittals Article.
    g. Bring cables and/or strands not meeting the requirements of the standard into full compliance.

D. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
    1. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

E. Document data for each measurement. Print data for submittals in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

F. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

2.11 INTEGRATED SOUND, PUBLIC ADDRESS SYSTEM

A. Definitions
1. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
2. VU: Volume unit.
3. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

B. Performance Requirements
1. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Seismic Performance: Provide supports and seismic restraints for control consoles, equipment cabinets and racks, and components that withstand the effects of earthquake motions determined according to SEI/ASCE 7.
    a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

C. Submittals
1. Product Data: For each type of product indicated.
2. Shop Drawings: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components. Include plans, elevations, sections, details, and attachments to other work.
    a. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
    b. Console layouts.
    c. Control panels.
    d. Rack arrangements.
    e. Calculations: For sizing backup battery.
    f. Wiring Diagrams: For power, signal, and control wiring.
        1) Identify terminals to facilitate installation, operation, and maintenance.
        2) Single-line diagram showing interconnection of components.
        3) Cabling diagram showing cable routing.
3. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
    a. Detail fabrication and assembly of supports and seismic restraints for control consoles, equipment cabinets and racks, and components.
4. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
5. Qualification Data: For qualified Installer and testing agency.
6. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.
    a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

7. Field quality-control reports.
8. Operation and Maintenance Data: For public address and mass notification systems to include in emergency, operation, and maintenance manuals.

D. Quality Assurance
1. Installer Qualifications: Installer must be or use a qualified Systems Integrator who is a manufacturer's authorized representative and who has NICET certified Audio Systems Personnel on his staff to oversee the installation, testing and commissioning of the units required for this project
2. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
a. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.
3. Source Limitations: Obtain public address and mass notification systems from single source from single manufacturer.
4. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
5. Comply with NFPA 70.

E. Coordination
1. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

F. Extra Materials
1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
a. Microphone: One.
b. Desk Stand(s): One.
c. Ceiling Speakers: Four
d. Horn-Type Loudspeakers: Two

G. Manufacturers
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Telecor, Inc.
b. Bogen Communications, Inc.
c. Rauland-Borg Corporation.

H. Functional Description Of System
1. System Functions: Provide the following system functions, components and capabilities:
a. 25 Volt paging system providing paging zones as indicated and determined by the Owner.
b. Two-way "amplified voice" communications between all locations equipped with Control Console and/or telephone system handset, and all locations equipped with a public address system speaker.
c. A system comprised of all solid state electronics, utilizing a microprocessor based central processor unit, power supplies, audio interface cards, control cards, input/output cards, telephone interface cards, transformers, paging amplifiers, and associated components as required for a complete system.

d. Modular design utilizing plug-in circuit cards to enable quick on-site replacement or addition of components for system expansion and modification.
e. Connect station wiring to the system using insulation displacement connectors to allow quick disconnection of field cables from the System terminal boards.
f. Storage of user programmable data in a non-volatile EEPROM memory to prevent memory loss during a power failure. Provide a system time clock that is capable of maintaining correct time for a period of 14 days in the event of a power failure. Return the system programming to the original factory default settings by keying a special code form the Console.
g. User capability to change system programming for all paging functions, bell functions, and clock functions – both master and slave. Provide the owner with the required training, documentation, and software to accomplish these functions.
h. Rack mount the Public Address main equipment including card cages and all cards, power amplifiers, program sources, and related components in the MDF. Provide remote system programming capability of Public Address and Master Clock features by an Administrative Control Console. Attending to the main equipment in the MDF for normal day-to-day operation of the system is not a necessary requirement. Systems requiring regular adjustment will be rejected.
i. User capability to selectively connect any zone to any available signal channel.
j. User capability to selectively control sound from microphone outlets and other inputs.
k. "All-call" feature that connects the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
l. Telephone paging adapter capability to allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
m. Administrative Control Console for facilitating all Public Address System announcements and programming, to include but not be limited to: Emergency all-call; paging zone and number assignments; call-in priority levels with tone characteristics; Master Clock event and tone signaling; monitor and reporting on call-in line faults; and manually distribute unique tones to all zones and speakers in the system.
n. Cabling, appropriate adapters and connection to a local building digital VoIP System (by Owner), allowing any telephone handset that is part of the telephone system to page and conduct hands free open voice communication with any speaker in the system; the Control Console; or any other classroom telephone. Connection to the local phone system shall not diminish or restrict any of the capabilities of local telephone system. Public Address System interfaces shall allow any programmed telephone to perform but not be limited to the following intercommunication system functions: all-call, zone call, intercom call to classroom speakers, distribute class change signals.
o. User programmable zone paging to all classroom and office speakers using microphone, Control Console or telephone. Public address zones shall be software programmable to include 2, 3, 4 digit numbers or a letter and a 3-digit number, or any combination. Zone paging shall be independent of time and program zones and shall provide easy access to groups of zones or all-zone pages.
p. Distribution of general announcements over school loudspeakers using a microphone, Control Console, or telephone handset, on an All-Call basis, pre-selected zone basis, or multiple-zone basis to any of eight paging zones. Speaker assignments to any of eight zones shall be user-programmable from the Control Console.
q. Distribution of emergency paging announcements over school loudspeakers using a microphone, Public Address Control Console, or telephone handset. Emergency announcements shall have the highest priority over other system functions.
r. Ability to designate individual room station within the system as a fixed zone by the simple entering of a single keystroke at the Control Console during a page selection.

s. Selection and monitoring of individual program sources (Microphone, AM/FM Tuner, or CD, MP3) and distribution by the Control Console.

t. Control Console programming of administrative microphone for control and distribution of public announcements, to eliminate the need to go to the central electronics for microphone set up. Keying the microphone shall automatically mute all other audio programs at a lower priority in the system. A preset shall be provided to mute all local sound systems by contact closure allowing the Public Address system to override local sound system programs. Microphone shall transmit to all rooms or specific speakers' zones as programmed in the system software.

u. The capability of multiple open voice intercom paths. Intercom paths shall be global.

v. Automatic gain control of intercom speech to assure constant speech level.

w. Automatic sounding of a warning tone over any loudspeaker selected for two-way communications to alert the classroom teacher to an incoming announcement.

x. A minimum of four channels for intercom communications or audio program distribution.

y. Emergency Calls that can be initiated from a single call key programmed at the classroom telephone.

z. The ability to monitor the school building either on or off the premises from a single telephone.

aa. Audio program distribution to eight different areas of the building selected by the Control Console. Inputs shall be provided for 5 low impedance microphones, tuner, CD player and auxiliary source. Program material shall include audio programs from standard AM/FM tuner, CD player, or auxiliary source. Provide program source equipment including AM/FM tuner, CD player. Provide Control Console with the ability to monitor program sources being distributed.

bb. Audio zones that are different than paging and time zones. Audio source equipment shall have the ability to be located remotely from the main system control electronics, and shall have the ability to distribute two channels of audio simultaneously if so desired. School shall be equipped with 1 rack mounted AM/FM tuner, 1 Rack Mounted CD player.

cc. RS232 Input/Output Interface, Personal Computer, Modem, and Printer for monitoring activity within System and for displaying and printing system management information. System shall perform diagnostics, or logging transactions either on or off premises.

dd. The ability to interface to the power supplies of door strikes (provided by others), to allow remote control of door strike through the paging system. The ability to control at minimum the exterior doors with Door Signally (DS) devices is required.

ee. Time Signal tones of an integrated Master Clock System to be distributed throughout zone selected for time signaling over programmed loudspeakers on a manual of automatic basis.

ff. Power amplifiers that provide a minimum power capacity of 2 watts per cone speaker location and Door Signaling device plus 15 watts of power per horn type speaker locations.

gg. Cabling that is specified by the manufacture, which provides shielding of conductors so that the Public Address System does not interfere with the Telephone Systems and Telephone System cabling.

hh. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.

ii. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

I. General Equipment and Material Requirements
   1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
   2. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.
   3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
   4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

J. Preamplifiers
   1. Preamplifier: Integral to power amplifier.
   2. Output Power: Plus 4 dB above 1 mW at matched power-amplifier load.
   3. Total Harmonic Distortion: Less than 1 percent.
   4. Frequency Response: Within plus or minus 2 dB from 20 to 20,000 Hz.
   5. Input Jacks: Minimum of two. One matched for low-impedance microphone; the other matchable to cassette deck, CD player, or radio tuner signals without external adapters.
   6. Minimum Noise Level: Minus 55 dB below rated output.
   7. Controls: On-off, input levels, and master gain.

K. Power Amplifiers
   1. Mounting: Console.
   2. Output Power: 25-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.
   3. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.
   4. Minimum Signal-to-Noise Ratio: 60 dB, at rated output.
   5. Frequency Response: Within plus or minus 2 dB from 50 to 12,000 Hz.
   6. Output Regulation: Less than 2 dB from full to no load.
   7. Controls: On-off, input levels, and low-cut filter.
   8. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

L. Transfer To Standby Amplifier
   1. Monitoring Circuit and Sensing Relay: Detect reduction in output of power amplifier of 40 percent or more and, in such event, transfer load and signal automatically to standby amplifier.

M. Microphones
   1. Paging Microphone:
      a. Type: Dynamic, with cardioid polar characteristic.
      b. Impedance: 150 ohms.
      c. Frequency Response: Uniform, 50 to 14,000 Hz.
      d. Output Level: Minus 58 dB, minimum.
      e. Finish: Satin chrome.
      f. Cable: C25J.
      g. Mounting: Desk stand with integral-locking, press-to-talk switch.

N. Volume Limiter/Compressor
   1. Minimum Performance Requirements:
      a. Frequency Response: 45 to 15,000 Hz, plus or minus 1 dB minimum.

b. Signal Reduction Ratio: At least a 10:1 and 5:1 selectable capability.
c. Distortion: 1 percent, maximum.
d. Rated Output: Minimum of plus 14 dB.
e. Inputs: Minimum of two inputs with variable front-panel gain controls and VU or decibel meter for input adjustment.
f. Rack mounting.

O. Control Console
1. Cabinet: Modular; complying with TIA/EIA-310-D.
2. Housing: Steel, 0.0478 inch minimum, with removable front and rear panels. Side panels are removable for interconnecting side-by-side mounting.
3. Panel for Equipment and Controls: Rack mounted.
4. Controls:
a. Switching devices to select signal sources for distribution channels.
b. Program selector switch to select source for each program channel.
c. Switching devices to select zones for paging.
d. All-call selector switch.
5. Indicators: A visual annunciation for each distribution channel to indicate source being used.
6. Self-Contained Power and Control Unit: A single assembly of basic control, electronics, and power supply necessary to accomplish specified functions.
7. Spare Positions: 20 percent spare zone control and annunciation positions on console.
8. Microphone jack.

P. Equipment Cabinet
1. Comply with TIA/EIA-310-D.
2. House amplifiers and auxiliary equipment at each location.
3. Cabinet Housing:
a. Constructed of 0.0478-inch steel, minimum, with front- and rear-locking doors and standard TIA/EIA-310-D-compliant, 19-inch racks.
b. Arranged for floor or wall mounting as indicated.
c. Sized to house all equipment indicated, plus spare capacity.
d. Include 20 percent minimum spare capacity for future equipment in addition to space required for future cassette deck and CD player.
4. Power Provisions: A single switch in cabinet shall disconnect cabinet power distribution system and electrical outlets, which shall be uniformly spaced to accommodate ac-power cords for each item of equipment.
5. Ventilation: A low-noise fan for forced-air cabinet ventilation. Fan shall be equipped with a filtered input vent and shall be connected to operate from 105- to 130-V ac, 60 Hz; separately fused and switched; arranged to be powered when main cabinet power switch is on.

Q. Equipment Rack
1. Racks: 19 inches standard, complying with TIA/EIA-310-D.
2. Power-Supply Connections: Compatible plugs and receptacles.
3. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.
4. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.
5. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with socket for 5-A cartridge fuse for rack equipment power.
6. Service Light: At top rear of rack with an adjacent control switch.
7. Vertical Plug Strip: Grounded receptacles, 12 inches o.c.; the full height of rack.
8. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.
9. Spare Capacity: 20 percent in rack for future equipment.

R. Telephone Paging Adapter
   1. Adapters shall accept voice signals from telephone extension dialing access and automatically provide amplifier input and program override for preselected zones.
   2. Minimum Frequency Response: Flat, 200 to 2500 Hz.
   3. Impedance Matching: Adapter matches telephone line to public address equipment input.
   4. Rack mounting.

S. Tone Generator
   1. Generator shall provide clock and program interface with public address and mass notification system.
   2. Signals: Minimum of seven distinct, audible signal types including wail, warble, high/low, alarm, repeating and single-stroke chimes, and tone.
   3. Pitch Control: Chimes and tone.
   4. Volume Control: All outputs.
   5. Activation-Switch Network: Establishes priority and hierarchy of output signals produced by different activation setups.
   6. Mounting: Rack.

T. Monitor Panel
   1. Monitor power amplifiers.
   2. Components: VU or dB meter, speaker with volume control, and multiple-position rotary selector switch.
   3. Selector Switch and Volume Control: Selective monitoring of output of each separate power amplifier via VU or dB meter and speaker.
   4. Mounting: Rack.

U. LOUDSPEAKERS
   1. Cone-Type Loudspeakers:
      a. Minimum Axial Sensitivity: 91 dB at one meter, with 1-W input.
      b. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
      c. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.
      d. Minimum Dispersion Angle: 100 degrees.
      e. Rated Output Level: 10 W.
      f. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
      g. Surface-Mounting Units: Ceiling, wall, or pendant mounting, as indicated, in steel back boxes, acoustically damped. Front face of at least 0.0478-inch steel and whole assembly rust proofed and shop primed for field painting. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically damped. Metal ceiling grille with white baked enamel is the standard for color. Refer to the floor plans and consult with the Architect for final approval of speaker grill colors in the Auditorium, Large Group Instruction Room, Gym, and other specialty spaces.
   2. Exterior Horn-Type Loudspeakers:
      a. Reentrant type: flush mount installation.
      b. Frequency Response: 600 to 14,000 Hz.
      c. Power Handling: 15 Watts RMS, 30 Watts Peak.
      d. Variable screw taps: 25 V transformer.
      e. Sound Pressure Level: 110 dB at 1 meter with 1-watt input.
      f. Exterior horn speakers shall be Atlas/Soundolier APF-15T Horn Speaker with weatherproof 95-R back box and VP60-R Speaker Baffle or approved equal.
      g. Flush-Ceiling-Mounting Units: In steel back boxes, acoustically damped. Circular metal grille in satin aluminum with clear acrylic coating.

V. Noise-Operated Gain Controller
   1. Design gain controller to continuously sense space noise level and automatically adjust signal level to local speakers.
   2. Frequency Response: 20 to 20,000 Hz, plus or minus 1 dB.
   3. Level Adjustment Range: 20 dB minimum.
   4. Maximum Distortion: 1 percent.
   5. Control: Permits adjustment of sensing level of device.
   6. Provide gain control capabilities for the Gym, Auditorium, Cafeteria, Metal Fabrication Shop, Carpentry Wood Shop, and Automotive Tech Shop.

W. Outlets
   1. Volume Attenuator Station: Wall-plate-mounted autotransformer type with paging priority feature.
      a. Wattage Rating: 10 W unless otherwise indicated.
      b. Attenuation per Step: 3 dB, with positive off position.
      c. Insertion Loss: 0.4 dB maximum.
      d. Attenuation Bypass Relay: Single pole, double throw. Connected to operate and bypass attenuation when all-call, paging, program signal, or prerecorded message features are used. Relay returns to normal position at end of priority transmission.
      e. Label: "PA Volume."
   2. Microphone Outlet: Three-pole, polarized, locking-type, microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed outlet covers.
   3. Headphone Outlet (for the Hearing Impaired): Microphone receptacles in single-gang boxes. Equip wall outlets with brushed stainless-steel device plates. Equip floor outlets with gray tapered rubber or plastic cable nozzles and fixed-outlet covers.

X. Battery Backup Power Unit
   1. Provide rack mounted unit, consisting of time-delay relay, sealed lead-calcium battery, battery charger, on-off switch, "normal" and "emergency" indicating lights, and adequate capacity to supply maximum equipment power requirements for one hour of continuous full operation.
   2. Provide unit that supplies public address equipment with 12- to 15-V dc power automatically during an outage of normal 120-V ac power.
   3. Provide battery on float charge when not supplying system and to transfer automatically to supply system after three to five seconds of continuous outage of normal power, as sensed by time-delay relay.
   4. Provide unit that automatically retransfers system to normal supply when normal power has been reestablished for three to five seconds continuously.

Y. Conductors and Cables
   1. Jacketed, twisted pair and twisted multipair, untinned solid copper.
      a. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inch thick.
      b. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
      c. Plenum Cable: Listed and labeled for plenum installation.

Z. Unspecified Equipment and Material.
   1. Provide any item of equipment or material not specifically addressed on the Drawings or in this Document and required to provide a complete and functional installation in a level of quality consistent with other specified items. Includes Lockable Equipment Cabinet sized for up to 25% future equipment expansion.

AA. Wiring Methods
1. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   a. Install plenum cable.
   b. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
2. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
3. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

BB. Installation of Raceways
1. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
2. Install manufactured conduit sweeps and long-radius elbows whenever possible.

CC. Installation of Cables
1. Comply with NECA 1.
2. General Cable Installation Requirements:
   a. Terminate conductors; allow no cable to contain un-terminated elements. Make terminations only at outlets and terminals.
   b. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
   c. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   d. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
   e. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   f. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Do not use heat lamps.
3. Open-Cable Installation:
   a. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   b. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
   c. Do not run cable through structural members or be in contact with pipes, ducts, or other potentially damaging items.
4. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

DD. Installation
1. Meet with the Owner prior to installation to determine and clarify all zoning requirements. Installation of the system will not begin until this meeting has occurred and the Contractor has provided a zoning plan to and received written approval from the Owner and Architect. Confirm locations of all control consoles with Owner and Architect prior to installation.
2. Design Criteria:
   a. Provide rooms with one speaker (as indicated on the drawings) with one circuit for intercom and a dedicated address.
   b. Provide rooms with more than one speaker as indicated on the drawings (i.e. the Metal Fabrication Shop, Carpentry Wood Shop, and Automotive Tech Shop and others) with two circuits as follows:
      1) Dedicate the speaker nearest the front of the room to a circuit to be used as intercom.
      2) Install the additional speaker(s) on a separate circuit. Run these speakers series, programmed to mimic the paging, time tone and program zones as the intercom circuit
   c. Install corridor speakers on individual circuits not to exceed 12 speakers. These speakers will also be used for audio monitoring of zones in crisis situations. Strict adherence to this criteria will be enforced
   d. Program exterior speakers circuits as one individual zone
3. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
4. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.
5. Equipment Cabinets and Racks:
   a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
   b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
   c. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.
6. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.
7. Wall-Mounted Outlets: Flush mounted.
8. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.
9. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating. Seal back boxes and baffles at building surfaces using silicone calking. Refer to Section 07 92 00 for Joint Sealant specifications.
10. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.
11. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

EE. Grounding
1. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

3. Install grounding electrodes as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

FF. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
3. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
4. Tests and Inspections:
   a. Schedule tests with at least seven days' advance notice of test performance.
   b. After installing public address and mass notification systems and after electrical circuitry has been energized, test for compliance with requirements.
   c. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.
   d. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
      1) Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
      2) Repeat test for each separately controlled zone of loudspeakers.
      3) Minimum acceptance ratio is 50 dB.
   e. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
   f. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
   g. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
   h. Signal Ground Test: Measure and report ground resistance at pubic address equipment signal ground. Comply with testing requirements specified in Division 26 Section "Grounding and Bonding for Electrical Systems."
5. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.
6. Public address and mass notification systems will be considered defective if they do not pass tests and inspections.
7. Prepare test and inspection reports.
   a. Include a record of final speaker-line matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.

GG. Startup Service
1. Engage a factory-authorized service representative to perform startup service.
a. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
b. Complete installation and startup checks according to manufacturer's written instructions.

HH. Adjusting
1. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.
2. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

II. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the public address and mass notification systems and equipment.

2.12 WIRELESS MASTER CLOCK SYSTEM

A. Definitions
1. NIST: The National Institute of Science and Technology.
2. PC: Personal computer.
3. UTC: Universal time coordinated. The precisely measured time at zero degrees longitude; a worldwide standard for time synchronization.

B. Performance Requirements
1. Seismic Performance: Master clock and housing shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

C. Submittals
1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes (including available colors) for each product indicated and describe features and operating sequences, both automatic and manual, for the following:
a. Master unit.
b. Indicating clocks.
c. Signal equipment.
d. Equipment enclosures and back boxes.
e. Accessory components.
2. Shop Drawings: For clock systems. Include plans, elevations, sections, details, and attachments to other work.
a. Wiring Diagrams: For power, signal, and control wiring and correction circuits.
1) Identify terminals and wiring color codes to facilitate installation, operation, and maintenance.
2) Indicate recommended wire types and sizes, and circuiting arrangements for field-installed system wiring. Show protection from over-current, static discharge, and voltage surge.

b. Details of seismic restraints including mounting, anchoring, and fastening devices for the following system components:
   1) Surface-mounted and semi-recessed secondary indicating clocks.
   2) Master clock enclosures.
   3) Clock circuit power boosters.
c. Details of seismic strengthening of master clock enclosures.
d. Dimensioned Outline Drawings of the Mounting Rack for the Master Clock: Show internal seismic bracing, and locate center of gravity of fully equipped and assembled unit. Locate and describe mounting and anchorage provisions.

3. Samples for Initial Selection:
   a. Manufacturer's color photographs or color chips showing the full range of colors available for clocks, signal equipment, and control panels.
4. Delegated-Design Submittal: For the master clock and housing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   a. Detail fabrication and assembly of the master clock and housing.
   b. Design Calculations: Calculate requirements for selecting seismic restraints.
5. Seismic Qualification Certificates: For the master clock, accessories, and components, from manufacturer.
   a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   c. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
6. Field quality-control reports.
7. Operation and Maintenance Data: For clock and program control to include in emergency, operation, and maintenance manuals.

D. Quality Assurance
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NFPA 70.S

E. Master And Secondary Clock System
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. American Time
   b. Sapling, Inc.
   c. Primex
3. Master Clock System
   a. Time programming shall be accomplished by way of a microprocessor-based and user-programmable master control system integrated within the Integrated Sound and System. The unit will further permit programming, diagnostics, and activity logging through connection to an external computer. The system shall be provided with a GPS antenna mounted to the roof as shown on the riser diagram with the necessary hardware-software to interface to the integrated communications system.
   b. Correction to the second, the master time controller shall provide all secondary clocks correction to the second.
   c. The master time controller shall provide the following functions:
      1) Wireless control of the slave 12” and 16” clocks located throughout the building

2) Wireless repeaters shall be provided in the MDF and IDF on each floor linked via a RS485 loop between the master clock and each repeater
3) Capacity for storing 900 events and up to 100 Holidays in nonvolatile memory.
4) Ability to review, edit and delete events
5) Review events from any entered time of day
6) Events shall be programmable to any or all of (8) zone circuits
7) Selection of any of (8) schedules to allow flexibility due to seasonal changes or special events
8) Fully automatic Holiday program execution.
9) User programmable Automatic Daylight Savings Time Change
10) Separate bell duration for each zone circuit
11) Latched operation of zones to control lighting or other devices
12) User-programmable custom slave clock correction. Output relays rated at five amperes shall be provided on all zone circuits.

d. The secondary clock shall be a wireless clock 12 or 16 inch depending on location. The clock will be capable of receiving a signal from multiple clocks. The clock shall receive and transmit with 915–928 MHz frequency–hopping technology. The clock is to be capable of transmitting the time simultaneously without interfering with each other. The clocks shall include automatic calibration, as well as a diagnostic function that allows the user to view the quality of the signal, the last time the clock received a correction signal, a gearbox test and a comprehensive analysis of the entire clock. The clock shall have a maximum correction time of five (5) minutes. It shall be designed to be used with the Repeater 1 for each of the 2 floors located in the data MDF and IDF, which can be regulated via wireless communication protocol. Upon receipt of the wireless signal, the clock will immediately self–correct. The clock shall have a semi–flush smooth surface ABS case. The dial is to be made of durable polystyrene material. The crystal is to be shatterproof, side molded polycarbonate. Glass and visible molding marks are unacceptable. The clock shall have black hour and minute hands as well as a red second hand.
e. Clocks in the gymnasium shall be 16” and provided with wire guards.
f. Digital LCD Multi-Line Administrative telephones integration, the time on the Digital LCD Multi-Line Administration telephones shall be automatically and continually synchronized with the schools Master Clock System which supports all the schools secondary clocks and class change tones. System that requires the owner to do periodic manual synchronization between the telephone systems clock and the schools Master Clock shall not be acceptable.

F. Installation
1. Mount system components with fastening methods and devices designed to resist the seismic forces indicated in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

G. Identification
1. Comply with Division 26 Section "Identification for Electrical Systems."
2. Color-code wires, and apply wire and cable marking tape to designate wires and cables so they are uniformly identified and coordinated with wiring diagrams throughout the system.

H. Field Quality Control
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installation, including connections.

2. Perform tests and inspections.
   a. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
3. Tests and Inspections:
   a. Perform operational-system tests to verify compliance with the Specifications and make adjustments to bring system into compliance. Include operation of all modes of clock correction and all programming and manually programmed signal and relay operating functions.
   b. Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
4. Clock system will be considered defective if it does not pass tests and inspections.
5. Prepare test and inspection reports.

I. Adjusting
1. Program system according to Owner's requirements. Set system so signal devices operate on Owner-required schedules and are activated for durations selected by Owner. Program equipment-control output circuits to suit Owner's operating schedule for equipment controlled.
2. Adjust sound-output level of adjustable signal devices to suit Owner's requirements.
3. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other-than-normal occupancy hours for this purpose.

J. Demonstration
1. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain clock-and-program-control system components.

2.13 MISCELLANEOUS CABLING SYSTEM

A. Provide and terminate all speaker, clock, microphone, antenna, etc. cabling per manufacturer’s recommendations for a completely operational system as specified.

B. Sound/Speaker cabling shall be home run and looped directly to applicable headend termination board, as specified. All cable runs shall be free from in-line splices. Insulate all cable shields (at field device end) from field grounds by cutting and taping shields.
1. Classroom speakers, office speakers, conference room speakers, work room speakers, exterior horn speakers and others areas that have only one (1) public address speaker shall each be individually home run, without splices, back to their respective sound or master clock headend. Provide 22 AWG solid shielded speaker cables.
2. Hallways and other areas that have multiple speakers, may have a maximum of eight (8) speakers per speaker loop home run, without splices, back to their respective sound headend. Provide 18 AWG stranded speaker cables.
3. Horn Speakers areas that have multiple speakers, may have a maximum of four (4) speakers per speaker loop home run, without splices, back to their respective sound headend. Provide 18 AWG stranded speaker cables.

C. Roof mounted Antenna, provide a RG-6U coax cable between the roof mounted antenna location and the AM/FM tuner location.
1. Cables shall be left coiled in backbox with minimum of 48" slack.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not install equipment and materials which have not been reviewed by the Architect. Equipment and materials which are installed without the Architect's review or without complying to comments issued with the review shall be removed from the project when so instructed by the Architect. No payment will be made for unapproved or removal if it is ordered removed. The Installer shall be responsible for any ancillary costs incurred because of its removal and the installation of the correct equipment and materials.

B. Obtain detailed information on installation requirements from the manufacturers of all equipment to be furnished, installed or provided. At the start of construction, check all Contract Documents, including all Drawings and all Sections of the specifications for equipment requiring electrical connections and service and verify electrical characteristics of equipment prior to roughing.

C. Equipment and systems shall not be installed without first coordinating the location and installation of equipment and systems with the General Contractor and all other Trades.

D. Any and all material installed or work performed in violation of above requirements shall be re-adjusted and corrected by the Installer without charge.

E. Refer to all Drawings associated with the project, prior to the installation or roughing-in of the electrical outlets, conduit and equipment, to determine the exact location of all outlets.

F. After installation, equipment shall be protected to prevent damage during the construction period. Openings in conduits and boxes shall be closed to prevent the entrance of foreign materials.

G. Home runs indicated are not to be combined or reduced without written consent from the Architect.

H. All connections to equipment shall be made as required, and in accordance with the approved submittal and setting drawings.

I. Delivery, Storage and Handling:
   1. Deliver, store, protect and handle products in accordance with recommended practices listed in Manufacturer's Installation and Maintenance Manuals.
   2. Deliver equipment in individual shipping splits for ease of handling, mount on shipping skids and wrap for protection.
   3. Inspect and report concealed damage to carrier within specified time.
   4. Store in a clean, dry space. Maintain factory protection or cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation. Meet the requirements and recommendations of NFPA 70B and the Manufacturer. Location shall be protected to prevent moisture from entering enclosures and material.
   5. Handle in accordance with NEMA and the Manufacturer's recommendations and instructions to avoid damaging equipment, installed devices and finish.

6. The equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the Manufacturer shall be required to brace the equipment suitably to insure that the tilting does not impair the functional integrity of the equipment.

J. Site Observation:
1. Site observation visits will be performed randomly during the project by the Architect. Reports will be generated noting observations. Deficiencies noted on the site visit reports shall be corrected. All work shall comply with the Contract Documents, applicable Codes, regulations and local Authorities whether or not a particular deficiency has been noted in a site visit report.
2. Be responsible to notify the Architect ten working days prior to closing in work behind walls, raised access floors, ceilings, etc., so that installed work can be observed prior to being concealed.
3. Areas shall stay accessible until deficiencies are corrected and accepted. Notify the Architect when all deficiencies are corrected. Return reports with items indicated as corrected prior to re-observation by the Architect.

K. Project Open House:
1. If the Owner elects to have an open house at the end of the project, provide assistance to the Owner. Cooperate and provide manpower to operate and demonstrate systems during the open house as requested by the Owner.

3.2 EQUIPMENT RACKS, CABINETS AND BRACKETS

A. Securely mount equipment racks, cabinets and wall mounted relay brackets to the building structure. Proper supports such as 3/8" lag screws and expansion anchors shall be used. Proper quantity of supports shall be utilized. Dry wall screws and other types of supports not specifically approved to support equipment are specifically prohibited. Submit mounting supports for approval before installation.

B. Position racks, cabinets, and wall mounted relay brackets in order to have minimum 3 foot clearance for easy access. Equipment racks, cabinets and relay brackets mounted on or against walls shall have 3 foot clearance in front of deepest component. Free standing equipment racks and cabinets shall have 3 foot clearance in front and rear of deepest components. Provide 3 foot clearance between free standing equipment racks or cabinets and any other obstruction to allow access from front to rear of rack or cabinet for maintenance.

C. The Electrical Contractor shall provide cable tray over each rack and cabinet as required to facilitate a neat and orderly installation of cables and to secure the top of the racks to the structure. Cables shall drop straight down to equipment racks. Cable trays shall be secured at both ends to the structure and connected together as required for a complete contiguous installation. Utilize proper supports to support the cable tray to the building structure as well as the equipment rack and cabinet. Submit mounting supports for approval before installation.

D. Cable Management: All cables shall enter the wiring closet to within the equipment racks and/or brackets. Secure the bundle(s) to the rack strain relief and wire management behind the patch panels and cross connect block panels. Install horizontal and side-mounted vertical cable management panels and brackets for routing and management of patch cables. Maintain EIA/TIA and BICSI standards on bundling, supporting and bend radii.

E. Once the cabling system has been installed and terminated, install all active components and surge protected power strips into the racks, cabinets and wall mounted relay brackets.

F. Surge Protected Outlet Strips: Mount UPS and surge protected outlet strips per Manufacturer's directions. Refer to details on the Drawings for mounting location.

3.3 TERMINATIONS

A. All copper conductors of every cable shall be completely terminated at both ends.

3.4 CABLE PATHWAYS

A. Install cables in pathways provided by the Electrical Subcontractor or required under execution part of this Section.

B. Provide all equipment and cabling for a complete installed operating system. In general, pathways, outlet boxes and grounding are provided by the Electrical Subcontractor.

C. All pathways provided under this Section shall comply with fill capacities as per Code, EIA/TIA 569 and BICSI.

D. Cable bending radius shall not be less than minimum required by EIA/TIA and BICSI.

E. Cabling installed concealed shall be supported from the building structure (e.g. cable trays, J-Hooks, etc.).

F. Cables shall be installed no closer than 12 inches (305mm) to electrical equipment and wiring. When cables are required to cross power wiring, they shall only do so perpendicular to the power wiring. Telecommunications cabling and power wiring shall only cross each other the minimal number of times as required due to building design limitations.

G. Clearances: Clearances between cabling and other building systems as required by EIA/TIA 569 and BICSI shall be maintained throughout the building.

H. All cables shall be installed in a neat and workman-like manner. Cables shall be installed parallel and perpendicular to building elements.

I. Provide expansion fittings and adequate cable slack at all building expansion joints.

J. Fire/smoke seal all conduits, raceways, sleeves, slots, etc. where cables pass from one location to another.

3.5 SEALING OF PENETRATIONS AND OPENINGS

A. Environmental Seals
   1. Provide seals on raceways exposed to widely different temperatures, as in refrigerated or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.
   2. Provide seals under device plates for outlets on walls between conditioned and non-conditioned spaces.

3. Provide outlet plate gasket seals at all work area outlets on interior and exterior walls.

3.6 SEISMIC SUPPORTS, SUPPLEMENTARY STEEL AND CHANNELS

A. Provide all supports, supplementary steel and channels required for the proper Seismic installation, mounting and support of all work installed under this Section.

B. All supports, supplementary steel and channels shall be furnished, installed and secured with all fittings, support rods and appurtenances required for a complete support or mounting system.

C. Supplementary steel and channels shall be firmly connected to the building construction in a manner approved by the Architect prior to the installation of same. Submit to the Architect, via the General Contractor, the locations proposed for using supplementary steel and channels for the support of equipment, fixtures and raceways. The submittal shall indicate the mounting methods, size and details of the supports, channels and steel; it shall indicate also that weight which the supports, channels and supplementary steel is to carry.

D. The type and size of the supporting channels and supplementary steel shall be of sufficient strength and size for seismic restraint and to allow only a minimum deflection in conformance with the channel and supplementary steel manufacturer's requirements for loading.

E. All supplementary steel and channels shall be installed in a neat and workmanlike manner parallel to the walls, floor and ceiling construction. All turns shall be made with 90 degrees and 45 degrees fittings, as required to suit the construction and installation conditions.

F. All supplementary steel, channels, supports, and fittings, shall be Underwriters' Laboratories, Incorporated, approved, be galvanized steel and be manufactured by Steel City, Unistrut, Power-Strut, T. J. Cope, Chalfant or approved equal.

G. Provide supports to meet the required Seismic rating as indicated under "Part One" of this Specification.

H. Provide beam clamps with set screws (C-clamp type).

I. Work under this Section shall be held in place by Seismic rated methods.

J. Supporting from the roof decking will not be acceptable.

K. Provide expansion anchors on masonry units or brick work. Power actuated supports will not be accepted.

L. Provide stainless steel or corrosion resistant supports in corrosive areas on wet or damp areas.

M. Support work from the building structure, independent of suspended ceilings, roof deck or other trades work. Where duct work, pipes, pipe racks, type of building construction materials or structural framing members provide obstruction or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels, in an approved manner.

N. All work shall be installed in a rigid and satisfactory manner and shall be supported by bar hangers in frame construction or shall be fastened directly with wood screws on wood, bolts with expansion shields on concrete or brick toggle bolts on hollow masonry units, and machine screws or welded threaded studs on metal. Threaded studs of the proper type and holding capacity driven in by a power charge and provided with lock washers and nuts are acceptable for mounting of equipment on solid concrete walls or slabs.

O. Obtain written permission from the General Contractor allowing use of power activated charges. Use only properly trained and licensed operators.

P. Do not use power charge driven supports for any work that is to be hung from a horizontal surface without written permission from the Architect.

Q. Preset inserts of the proper type and holding capacity shall be used in overhead slab construction wherever possible.

R. Provide lateral supports for work to prevent excessive movement during a seismic event using rods, braces or galvanized or stainless steel cables.

S. Pendants, supports or hanging rods longer than 12 inches (300mm) shall be laterally braced.

T. Where installed in damp, wet and areas requiring wash down, all surface mounted panels, boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 26 00 00 "Identification for Electrical Systems."
   1. Confirm labeling scheme with the Owner prior to final labeling.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

E. Cable and Wire Identification:
   1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
   3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
   4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
      b. Label each unit and field within distribution racks and frames.
   5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Provide preprinted or computer-printed type labels with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:
   1. Cable Labels: Use flexible vinyl or polyester that flexes as cables are bent.

3.8 CABLE SUPPORTS

A. Provide strain relief hardware for backbone cables at each floor level as they pass from one floor to the next.

B. Provide hook and loop (Velcro) cable wraps at all panels, equipment racks and cabinets. Cable ties are specifically prohibited.

C. Cable ties for horizontal cables shall be secured with minimum required compression in order to secure the cables properly without impeding the signal transmission rating (geometry) of the cable. Hook and loop (Velcro) cable wraps may be used in lieu of cable ties for copper cables only. Cable-ties are specifically prohibited for fiber optic cables.

D. When pathways are not provided or specified, provide J-Hook supports from the building structure as required for cable runs to the cable drop location. Maximum distance between supports shall be five feet depending on the structural elements of the building. Maximum number of cables per support shall be thirty. Provide additional supports as required when cable quantities exceed thirty and to maintain required bending radius of cables. Cables installed exposed or in areas subject to abuse (below 10 feet (3m) above finished floor) or in accessible areas shall be installed in conduit.

E. All cables shall be supported directly from building structure. Under no circumstance shall cable be installed using cross bracing, plumbing/sprinkler pipes, ceiling systems or any other system that is not a specifically approved method to independently support cables. Cables shall not be allowed to rest on ceiling tiles, duct work, piping, etc. Supports shall be provided as required in order for cables to avoid contact with any other building system. Bundle cables in groups by Room.

3.9 CABLE PROTECTION

A. Provide bushings in all metal studs and the like where cables will pass through. Bushings shall be of two (2) piece construction with one piece inserted through the opening and the second piece locking it into place. Single piece bushings with locking tabs or friction fit are specifically prohibited.

B. Cables to be installed in existing enclosed open bays or furred spaces where conduit stubs are not provided shall be protected from chafing or any damage. The Installer shall verify that the warranty shall not be violated before installing any cabling in these locations.

C. Provide cutting, coring, sleeves and bushings and seal as required at all penetrations.

D. Fiber optic backbone cables shall be installed in inner duct.

E. Cables damaged during installation shall not be repaired. They shall be completely replaced with new cable.

3.10 INSTALLATION

A. All cabling shall be installed in conduit where indicated on plans, or shall be installed open using other methods, approved by architect, such as J-Hooks.
   1. Install wiring, per manufacturers recommendations. Use UL listed plenum cable in environmental air spaces including plenum ceilings.

B. All wiring shall be new and concealed in pipe where exposed.

C. All conduits and raceways shall have pull strings remaining after cable is pulled.

D. Impedance and Level Matching:
   1. Carefully match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

E. Control Circuit Wiring:
   1. Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
   2. Make installation in strict accordance with approved manufacturer's drawings and instructions.
   3. The Installer shall provide necessary transient protection on the AC power feed, all station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

F. Weatherproofing:
   1. Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

G. Typical Layouts and requirements of the specified systems:
   1. Typical layout:
      a. Equipment racks and cabinets
      b. Backbone cabling
      c. Headend equipment
   2. Typical layout of telecommunications equipment racks and cabinets.
      a. Each equipment rack and cabinet shall contain the following equipment:
         1) Fiber optic patch panel
         2) Fiber optic cable management
         3) Surge protector power strip
         4) Patch panels - Horizontal distribution
         5) Horizontal distribution cable management
         6) Vertical cable management
         7) Patch cords
      b. Provide space for the installation of network electronics equipment in the equipment racks.
      c. Furnish and install horizontal cable management between each patch panel (fiber optics, Hub distribution, Horizontal distribution, and telephone distribution).
      d. Furnish and install horizontal distribution patch panels in each wire center with sufficient ports to terminate all modular jacks shown on the drawings plus twenty percent spares. The exact number of modular jacks and horizontal distribution patch panels shall be obtained from the drawings.
      e. Furnish and install all equipment racks and cabinets required to support the aforementioned equipment.
      f. The MDF room shall contain fiber optic patch panel quantities which correspond to the total number of fiber optic patch panels located in the IDF rooms.
      g. Grounding bars shall be installed under SECTION 260000. Furnish and install the required grounding to ensure that all of the aforementioned equipment is grounded and bonded.
   3. Headend
      a. The headend consists of connecting hardware for the following:
         1) Video System
         2) Paging System
         3) Master Clock System
      b. Final terminations from IDC cross connect block panels to telephone equipment and PBX by -Telephone Company and Equipment Installer. Coordinate with Telephone Company and Equipment Installer for final terminations.
      c. Final terminations from the IDC cross connect block panels to the headend equipment shall be provided by the headend equipment installer.
      d. Coordinate with the headend equipment installer and the electrical contractor for:
         1) The installation of all the IDC cross connect block panels at the headend equipment. Installation shall be neat in appearance.
         2) The final terminations at the headend.

3.11 TRAINING

A. As a minimum, training sessions shall consist of the following:
   1. General project information and review shall be by the General Foreman or Superintendent of the Trade.
   2. Specific system training shall be by a Factory Trained Representative.
   3. Provide a complete review of the project and systems including, but not limited to, the following:
      a. In a classroom environment review each Record Drawing (use of typicals is acceptable).
      b. Note equipment layouts, locations and control points.
      c. Review each system.
      d. Review system design operation and philosophy.
      e. Review alarms and necessary responses.
      f. Review standard troubleshooting techniques for each system.
      g. Review areas served by equipment.
      h. Identify color codes used.
      i. Review features and special functions.
      j. Review maintenance requirements.
      k. Review operation and maintenance manuals.
      l. Respond to questions (record questions and answers).
   4. After classroom training, walk the entire project, review each equipment room and typical locations. Explain equipment and proper operation.

B. During the instruction period the Owner and Maintenance Manual shall be used and explained.

C. The Owner and Maintenance Manual material shall be bound in 3-ring binders and indexed. On the edge of the binder provide a clear see-through plastic holder with a typed card indicating the Project name, the Architect's name, the installer's name and the Volume number (e.g., Vol. No. 1 of 2).

D. Provide name, address and telephone number of the manufacturer's representative and Service Company for all items supplied so that the source of replacement parts and service can be readily obtained.

E. Include copies of manufacturers and installer's warranties and maintenance contracts and performance bonds properly executed and signed by an authorized representative.

F. Include copies of all test reports and certifications.

3.12 ACCEPTANCE DEMONSTRATIONS

A. Systems installed under this Section shall be demonstrated to the Owner and Architect. Demonstrations are in addition to necessary testing and training sessions. Notify all parties at least 7 days prior to the scheduled demonstration. Schedule demonstrations, in cooperation with and at times convenient to all parties, so as to not disturb ongoing activities.

B. Systems shall be tested prior to the demonstrations and each system shall be fully operational and tested prior to arranging the Acceptance Demonstration. Final payments will be withheld until a satisfactory demonstration is provided for all systems indicated or requested.

C. If the demonstration is not totally complete, performing all functions, features and connections or interfaces with other systems, or if there is a failure during the demonstration, additional demonstrations shall be arranged. Provide and pay for all costs, labor and expenses incurred for all attendees for each additional demonstration required for acceptance and demonstration of complete system operation.

D. Demonstrations shall be scheduled in ample time to complete all activities prior to final acceptance and Owner occupancy. Demonstrations shall take place at least 30 days prior to the scheduled project completion date and 30 days prior to owner's use and occupancy.

E. As a minimum, provide demonstrations for systems indicated under "Work Included" under Part One of the Specifications. Provide demonstrations of additional systems as requested by the Owner, or Architect.

3.13 PROJECT OWNER COORDINATION

A. Prior to Substantial Completion of the project and in ample time to address and resolve any coordination issues, request and arrange meetings between the Owner, Owner's Vendors and Consultants, Architect and General Contractor to discuss the Scope of Work for each system being provided and the interface required for a fully functional and operational system upon project completion. Initial meetings shall be scheduled three months prior to the scheduled Substantial Completion date or as soon as Submittals are submitted and reviewed for projects with shorter schedules.

B. At these meetings the required interface with the Owner shall be reviewed, requests for information required to complete programming or for coordination shall be presented and system operation and philosophy shall be discussed.

C. Additional meetings shall be held as requested by any party so that all issues are resolved and with the goal and intent being that all systems are fully operational and functional upon project Substantial Completion and that the responsibility for all components required is clearly established.

3.14 CLEANING UP

A. Upon completion of all work, and testing, thoroughly inspect all exposed portions of the installation and completely remove all exposed labels, markings, and foreign material.

B. The interior of all boxes and cabinets shall be left clean; exposed surfaces shall be cleaned and plated surfaces polished.

C. Repair damage to finish surfaces resulting from work under this Section.

D. Remove material and equipment from areas of work and storage areas.

E. All equipment shall be clean from dirt, dust, and fingerprints prior to final acceptance.

F. Touch up all damaged pre-finished equipment using materials and methods recommended by the Manufacturer.

3.15 PROJECT CLOSEOUT

A. Provide close out submittals as required herein and in SECTION 01770 - PROJECT CLOSEOUT including the following close out submittals.
   1. Operation and Maintenance Manuals
   2. Record Drawings.
   3. Test Reports.
   4. Extra Materials.

B. Obtain written receipts of acceptance close out submittals submitted. Receipts shall specifically detail what is being delivered (description, quantity and specification section) and shall be dated and signed by firm delivering materials and by the Owner's Representative.

C. Telecommunications:
   1. Provide fifteen (15%) spare patch cables and line cord for each cable length provided.
   2. Provide record drawings indicating actual cable routing and cable terminations and all required identifiers. Provide copy mounted in each telecommunications closet and the main cross connect.
   3. All sketches, drawings, and charts herein are for the purpose of providing for specifications in a simplified format. Errors and omissions in such does not relive the Contractor of the responsibility for providing a fully complete, secure and properly operating integrated instructional technology network system suitable for the intended use. Bidders must obtain a complete set of Project Drawings and Specifications to determine the full scope of work. In case of conflict the Project Drawings and Specifications shall prevail.

D. Construction Waste Management

E. Comply with Division 1 requirements for construction waste management and recycling.

END OF SECTION

SECTION 280800
COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. OPR and BoD documentation are included by reference for information only.

1.02 SUMMARY

A. This Section includes general requirements that apply to implementation of the commissioning process without regard to specific systems, assemblies, and components.

B. Related Sections include the following:
1. Division 01 Section 019113 Commissioning General Requirements for general commissioning process activities.
2. Division 21 Fire Suppression
3. Division 23 HVAC
4. Division 26 Electrical

1.03 DEFINITIONS

A. Commissioning Plan: A document, prepared by CxA, that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process. This Plan is included in Volume 4 of these specifications.

B. CxA: Commissioning Authority.

C. Quality Assurance: A program for the systematic monitoring and evaluation of the various aspects of a system, assembly, or component to ensure that standards of quality are being met. This is the responsibility of the CxA.

D. Quality Control: A system for ensuring the maintenance of proper standards in systems, assemblies, and components. This is the responsibility of the Contractor.

E. Official: State or Local official having jurisdiction over the conveying systems

F. Systems, Assemblies, Equipment, and Components: Where these terms are used together or separately, they shall mean “as-built” systems, assemblies, equipment, and components.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 CONSTRUCTION CHECKLISTS

A. The CxA shall provide Construction Checklists to the Contractors for execution that will indicate expected Quality Control features required for a highest-quality installation. The contractor shall complete the checklists as construction progresses and return them to the CxA as indicated in Section 01 9113 Commissioning General Requirements.

B. Checklists for this section will include:
   1. Fire Alarm
   2. Security System

C. A sample installation checklist is included to show the typical scope and rigor of the process.

3.02 PREREQUISITES TO TESTING

A. Prior to the testing of these systems or assemblies, the Contractor shall certify that:
   1. The system or assembly is completely installed and functional
   2. Work performed by other trades, but essential for this system or assembly's operation, is complete (e.g., electrical components are wired and power is provided)
   3. All contractor-performed start-up procedures and tests are complete.
   4. The system or assembly is ready for the Owner to take beneficial use.

3.03 SYSTEM OR ASSEMBLY TEST REQUIREMENTS

A. The CxA will provide Functional Performance Test procedures to the Contractor for execution for the following specific systems, assemblies, and components:
   1. Fire Alarm System
   2. Security System

B. Acceptance criteria and test details will be in accordance with the related sections including the following:
   1. Division 01 Section 01 9113 Commissioning General Requirements for general commissioning process activities.
   2. Division 21 Fire Suppression
   3. Division 23 HVAC
   4. Division 26 Electrical

C. A sample functional performance test is included to show the typical scope and rigor of the process.

3.04 TEST REPORTS

A. Provide copies of all reports required in the listed reference sections (see Section 1.2 SUMMARY above for the sections) for review.

3.05 SAMPLE FORMS

Installation Checklist
Fire Alarm

Reference Specification: 16721
Reference Drawing: E001, E528 and power plans

Model Verification

	Specified	Submitted	Installed
Manufacturer	Edwards, Notifier, Siemens Cerberus Pyrotronics, Simplex		
Model Number			
Serial Number	N/A	N/A	
Capacity			

Installation Checks

ID	Description	Pass	Fail	Comments
1	Verify fire alarm components are installed per the contract documents; see drawings for device locations and drawing E001installation height requirements. for each type of device.	☐	☐	
2	Fire alarm control panel FACP installed in room #429 with : (16721-2.10) 1. Alphanumeric display 2. Lockable steel surface mounted enclosure identified with Red nameplate not to exceed 72" mounting height. 3. local Visual and audible signals 4. Firefighters telephone control module 5. manual switching functions including Acknowledge, silence, test, and reset functions	1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐	1. ☐ 2. ☐ 3. ☐ 4. ☐ 5. ☐	
3	Fire Alarm annunciator panel installed in corridor #426 with : (16721-2.11) 1. Duplicate annunciator and control functions of the FACP 2. Alphanumeric display 3. Surface mounted	1. ☐ 2. ☐ 3. ☐	1. ☐ 2. ☐ 3. ☐	
4	Manual pull stations : Semi Flush, recessed back boxes, Red plastic or metal box with raised letter operating instructions, and a key or wrench station reset feature. (16721-2.3)	☐	☐	
5	Smoke Detectors – plug-in arrangement with integral visual indicating light (16721-2.4)	☐	☐	
6	Heat Detectors – plug-in base, interchangeable with smoke detector base (16721-2.5)	☐	☐	
7	Notification appliances, visual devices with clear or nominal white polycarbonate lens with FIRE engraved on lens (16721-2.6)	☐	☐	

8	Firefighters Telephones with handsets, high impact plastic coil cord and hook switch, located at: (16721-2.7) 1. Each elevator car 2. each elevator lobby 3. inside each stairwell at each floor 4. fire pump room 5. each elevator machine room	1. ☐ 2 ☐ 3. ☐ 4. ☐ 5. ☐	1. ☐ 2. ☐ 3. ☐ 4 ☐ 5. ☐	
9	All fire alarm wiring to be installed in metal raceway (16721-3.2-A)	☐	☐	
10	All fire alarm wiring to be color coded alarm supervisory, and alarm initiating wiring to be different color code from building wiring and from each other. (16721-3.2-D)	☐	☐	
11	All fire alarm system junction box covers to be painted RED. (16721-3.2-D)	☐	☐	

Approvals (only one required)

	Name (printed neatly)	Signature	Date
Manufacturer Representative			
Construction Administrator			
Commissioning Agent			

Functional Performance Test

Fire Alarm

1. Participants

Name/Representing		Participation (Testing, Witness, etc)
/		
/		
/		

Party filling out this form _____ Date of test _____

2. Prerequisite Checklist

(Y/N) A completed report of installation inspection, adjusting and settings for the Fire Alarm System by factory authorized service representative has been provided. Including the following written report/tests as outlined in specifications section 16725-3.5.

1. Fire Alarm has been testing according to the procedures outlines in NFPA 72..
2. Absence on unwanted voltages between circuit conductors and ground.
3. Test all conductors for short circuits
4. .Test each initiating and indicating device for alarm operation and response at the control unit. Test smoke detectors using the walk test.
5. Test the system for all specified functions according to the approved operation and maintenance manual. Initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communication options. For each item observe related performance at all devices required to be affected by the item under all system sequences. Observe indicting lights, displays, signal tones, and annunciator indications.

(Y/N) The Owners representative and building occupants have been notified.

(Y/N) The Fire Department/fire officials (AHJ) have been notified.

(Y/N) The general contractor has certified that the construction is substantially complete and ready for third-party verification. GC initials: _ _. Date: _ _.

(Y/N) Record all values for setpoints, control parameters, limits, delays, lockouts, schedules, etc., that were changed to accommodate testing:

Parameter	Pre-Test Values	Returned to Pre-Test Values √
		☐
		☐

Parameter	Pre-Test Values	Returned to Pre-Test Values √
		☐
		☐

Pre-Test Checklist

☐ The System is in normal operating mode and there are no Alarms or Alerts on Fire System Panel.

3. Notes:

4. Functional Testing Record

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
1	PREPERATION	1. Notify the local authority that there will be testing of the fire alarm system and that the system will be off-line until further notice.	1. Alarms that are activated will not notify the local authorities.	Y / N	
2	ACTIVATION	1. De-activate the notification circuit. Actuate 25% of devices, either with Pull station, smoke, or a magnet. Activation of initiating device causes the following to occur **: (See below for list of initiating device activations)**	1. The device will activate the alarm system and the location on the screen will be detailed enough to provide an exact location of the alarmed device.	Y / N	
3	NOTIFICATION	1. Activate a device. When the alarm is issued, inspect the horn strobes to make sure that all are sounding and that the lights are synchronized.	1. All of the notifications will be synchronized.	Y / N	
4	FACP power supply check	1. Simulate a Loss of primary power to FACP.	1. FACP will switch to secondary power supply and a trouble signal will be sent to FACP and remote annunciator. A “on emergency power” light should be illuminate at both locations.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
5	Duct Smoke detectors	1. Simulate/activate duct smoke detector.	1. Alarm signal sent to FACP and supply and return fans of appropriate AHU will shut down.	Y / N	
6	Elevator Recall	1. Operate/activate smoke//low temp heat detector in elevator shaft. 2. Operate /activate high temp heat detector	1. Elevator recall is activated 2. Shunt trip circuit is activate to shut down power to the elevator.	Y / N	
7	Sprinkler Valve tamper Switch	1. Activate sprinkler tamper switch.	1. A supervisory audible and visible "Valve Tamper" signal is indicated at the FACP and remote annunciator. The System records event and prints record.	Y / N	
8	Fire Pump monitoring	1. Simulate operation or alarm condition at fire pump: pump running. Loss of phase, phase reversal, controller connected to alt source, loss of water.	1. FACP and remote annunciator receive a supervisory audible and visible signal. System records event and prints record.	Y / N	
9	Initiating device removal	1. Manually remove alarm-initiating devices.	1. A "trouble" signal indication at the FACP and Remote annunciator for the device or zone involved.	Y / N	

Seq. ID	Mode ID	Test Procedure (including special conditions)	Expected Response	Pass Y/N	Notes
10.	FACP Instruction card	1. Verify Printed instruction card which includes a description of appropriate response from display and signals, and brief descriptions of the functional operations of the system under normal , alarm, and trouble conditions.	1. Instruction card is present..	Y / N	
11	AHJ NOTIFICATION	1. Restore the system to normal operation. Notify the AHJ that there will be a test of the alarm system and request that they stay on the line and state when the alarm comes in to them and repeat the message. 2. Activate a device and record the time from activation to AHJ notification.	1. The AHJ should be notified within 10 seconds of the original alarm.	Y / N	

*** Operation of an initiating device shall cause the following to occur:**

1. Audio Visual notification devices will activate (devices will be synchronized)
2. FACP and Remote annunciator panel will receive ID of initiating device in alarm.
3. Remote annunciator panel receives an alarm.
4. Unlocking of electric door locks in designated egress paths.
5. Release of magnetic door holders to close fire and smoke doors.
6. Elevator recall only on activation of smoke or heat detector in associated elevator shaft, machine room, or lobby.
7. Smoke dampers close in ducts serving area in alarm.
8. Event recorded in memory
9. Send alarm signal to local fire department.

END OF SECTION 280800

SECTION 31 0125

LANDSCAPE MAINTENANCE

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide continuous Landscape Maintenance, complete and as specified during progress of the work, after installation, for Preliminary Review and for the 90 day Maintenance Period. Also included is the Warranty Period Close Out and Final Inspection for Landscape Planting.

1 Refer to Section 32 9200 Lawns and Grasses for the types of lawns and grasses included in the work.

2 Refer to Section 32 9000 Planting and the Plant list on the drawings for the types of planting included in the work.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Existing Plants to Remain - Section 31 1320
2 Soil Preparation - Section 32 9113
3 Planting - Section 32 9000
4 Lawns and Grasses - Section 32 9200

1.04 REFERENCES

A "Arboriculture: Care of Trees, Shrubs and Vines in the Landscape" by Richard W. Harris, Prentice-Hall, Inc. 1983.

1.05 SUBMITTALS

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Materials Submittals

1 Slow Release Fertilizer for Lawns, manufacturer's product analysis and applicable data.

C Quality Control Submittals

1 Schedule of Maintenance Operations and Monthly Status Report: including list of equipment, materials proposed for the job and watering schedule.

2 Licenses, permits and insurance required by Local, the State and Federal government pertaining to maintenance work.

3 Monthly Record: All materials, fertilizers, insecticides and disease control chemicals used for the project. State when used and for what purpose and the rate(s) of application and the time(s) of application.

4 Written application recommendation by a licensed agricultural pest control advisor for all weed, pest and disease controls restricted by the State of Massachusetts proposed for this work.

5 Monthly record of all watering for the project.

D Project Close-out Submittal: Include in a single, 3-ring binder a landscape maintenance manual containing an indexed collection of all schedules, records and permits listed above, as well as a documentation of accepted condition of Planting and Lawns at Final Acceptance. Submit three (3) copies of the manual in accordance with Section 01 7700 – Project Closeout.

1.06 QUALITY ASSURANCE

A Qualifications

1 Experience: The landscape contractor or maintenance subcontractor shall have one of the full-time employees of his assigned to the job as foreman as needed for the duration of the contract. He/she shall have a minimum of four (4) years experience in landscape maintenance supervision, with experience or training in (turf management), entomology, pest control, soils, fertilizers and plant identification.

a There shall be a State registered arborist with at least 5 years experience for all pruning and disease diagnoses.

2 Labor Force: The landscape maintenance labor force shall be thoroughly familiar with, and trained in, the work to be accomplished and shall perform the task in a competent, efficient manner acceptable to the Owner.

B Requirements

1 Supervision: The foreman shall directly supervise the work force at all times. Notify the Landscape Architect of all changes in supervision.

2 Identification: Provide proper identification at all times for landscape maintenance firm's vehicles and labor force. Be uniformly dressed in a manner satisfactory to the Owner.

1.07 PROJECT/SITE CONDITIONS

A Site Visit: At beginning of maintenance period, visit and walk the site with the Owner's representative to clarify scope of work and understand existing project/site conditions.

B Documentation of Conditions: Document general condition of existing trees, shrubs, vines, groundcovers and lawn recording all plant materials which are healthy, thriving, damaged, dead or dying.

1.08 SEQUENCING AND SCHEDULING

A Perform all maintenance during hours mutually agreed upon between Owner and Contractor.

B Work force shall be present at the project site at least once a week and as often as necessary to perform specified maintenance in accordance with the approved maintenance schedule.

1.09 PHASING

A Preliminary Review, Maintenance and Final Acceptance may be divided into a maximum of two (2) phase if approved by the Architect.

1.10 PRELIMINARY REVIEW

A Preliminary Review: As soon as all lawns and plantings are completed per Contract Documents, the Contractor shall request in writing Preliminary Review to determine the condition of the work in the affected Sections listed below:

1 Affected Sections:

a Section - 31 1320 Existing Plants to Remain

b Section - 32 9200 Lawns and Grasses

1) Refer to Section 32 9200 – Lawns for grass coverage requirements and other acceptability requirements necessary to attain an acceptable PRELIMINARY REVIEW. PRELIMINARY REVIEW Acceptance initiates the beginning of the 90 day maintenance period (se 1.09).

2) The lawn Warranty Period coincides with the 90 DAY MAINTENANCE PERIOD. (see 1.09.B)

c Section - 32 9000 Planting

2 Within 10 days of the receipt of the written request, the Owner's Representative, the Contractor and the Landscape Architect will review the work completed for conformance to the Contract Documents.

3 Corrective Work:

a Work requiring corrective action or replacement shall be performed within ten (10) calendar days of the review(s).

b Perform corrective work and materials replacement in accordance with the drawings and specifications, and shall be made by the Contractor at no cost to the Owner.

c Continue maintenance of all landscaped areas until such time as all corrective measures have been completed and accepted for Preliminary Review.

4 Pruning: All pruning shall be done during the Preliminary Review unless otherwise required by the Landscape Architect.

1.11 90 DAY MAINTENANCE PERIOD

A Beginning of the 90 Day Maintenance Period

1 The date on which the Landscape Architect issues a letter of Preliminary Review Acceptance to the Contractor shall be the date of the beginning of the 90 Day Maintenance Period.

a If the 90 Day Maintenance Period covers the months of December, January, February, and March, it shall be extended automatically in order that the 90 Day Maintenance Period day count will pick up again April 1, and the tree maintenance and lawn cutting maintenance will be for an actual 90 days of active growth. All other aspects of the 90 Day Maintenance requirements will remain in effect through December, January, February, and March and until the end of the automatically extended 90 Day Maintenance Period at no additional cost to the Owner.

1) All plants not meeting these conditions shall be replaced at this time if within an acceptable planting season, otherwise within the next planting season. A new 90 Day Maintenance Period will be commenced for such plants.

B 90 Day Lawn Warranty

1 Lawns: Section 32 9200 - The Warranty is for the duration of the 90 Day Maintenance Period. The Warranty Ends at acceptance of the 90 Day Maintenance Period. See 32 9200 – 1.08 for acceptance criteria.

C One Year Plant Warranty

1 Refer to Section 32 9000 for specific Warranty requirements.

2 Planting: The One – Year Warranty begins at the acceptance of the 90 Day Maintenance Period and ends at the Acceptance of the Final Acceptance of Landscape Maintenance.

D Maintenance During the 90 Day Maintenance Period:

1 Existing Plants to Remain Maintenance - Section 31 1320

a The Contractor's Maintenance of all Plants and Mulch (In Areas Not to be Disturbed) shall continue until the Date of Final Acceptance of Landscape Maintenance.

2 Lawn and Grasses Maintenance - Section 32 9200

a The Contractor's Maintenance of Lawns stops at the date of the Landscape Architect 's Letter of Acceptance of the 90 Day Maintenance Period.

b The Owner's Maintenance of Lawns shall begin the date the Landscape Architect issues a Letter of Acceptance of the 90 Day Maintenance Period.

3 Plant Maintenance - Section 32 9000

a The Contractor's Maintenance of all plants shall stop at the date of the Landscape Architects letter of Acceptance of the 90 Day Maintenance Period.

b The Owner's maintenance of plants shall begin at the date the Landscape Architect issues a letter of Acceptance of the 90 Day Maintenance Period.

E Acceptance of the 90 Day Maintenance Period

1 The Contractor shall submit a written request to the Landscape Architect for the review for Acceptance at least five (5) working days prior to the anticipated review date, which would be the end of the 90 Day Maintenance Period's Date.

2 Within 10 days of the receipt of the written request, the Owner's Representative, the Contractor and the Landscape Architect will review the work completed for conformance to the Contract documents.

3 Work included in the 90 Day Maintenance will be accepted by the Landscape Architect upon satisfactory completion of the Maintenance Work; however, it will be exclusive of the Final Acceptance of the Irrigation System and Plant Materials which are still under Warranty until Final Acceptance of Landscape Maintenance.

4 Conditions for Acceptance of the Work

a Each plant and the lawn shall be alive and thriving, showing signs of growth and no signs of stress. For additional conditions of acceptance, see the respective sections below:

1) Section 31 1320 - Existing Plants to Remain

2) Section 32 9200 – Lawns and Grasses

3) Section 32 9000 – Planting

5 Replacements

a See the Respective Sections below:

1) Section 31 1320 - Existing Plants to Remain

2) Section 32 9200 – Lawns and Grasses

3) Section 32 9000 – Planting

1.12 ONE YEAR LANDSCAPE PLANTING WARRANTY

A Planting: Warranty begins on the date of the Landscape Architects acceptance of the 90 Day Maintenance Period and ends on the date of the Landscape Architects Final Acceptance for Landscape Planting One Year Warranty.

1.13 FINAL ACCEPTANCE LANDSCAPE PLANTING ONE YEAR WARRANTY

A The Contractor shall request in writing Final Acceptance Review at the end of the Warranty Period for Planting.

1 Within 10 days of the receipt of the written request, the Owner's Representative and the Contractor will review the work completed for conformance to the Contract documents.

2 Landscape Maintenance Manual: Submit binder to Owner during the Final Acceptance Review with all documentation and records required and utilized during the maintenance period.

3 Corrective Work

a Work requiring corrective action or replacement shall be performed within ten (10) calendar days of the review(s).

b Perform corrective work and materials replacement in accordance with the drawings and specifications, and shall be made by the Contractor at no cost to the Owner.

c Continue maintenance of all landscaped areas until such time as all corrective measures have been completed and accepted at Final Acceptance.

B Remove and dispose of all tree stakes, tree guys and tree wrap from all deciduous trees just before Final Acceptance Review.

C Final Acceptance

1 After all necessary replacements and corrective work have been reviewed and accepted by the Owner and if terms of Warranty (as specified in the respective section(s) are complete and acceptable in the judgment of the Owner will issue a written Final Acceptance of the Landscape Maintenance Work specified in this Section.

2 Keys and Identification: Return all keys and identification materials, if any, supplied by the Owner for the purpose of site access.

1.14 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect's designated representative.

PART 2 – PRODUCTS

2.01 MATERIALS

A General: All materials and equipment shall be provided by the Contractor, except as specified below.

B Water: Clean, potable and fresh, as available from Owner.

C Fertilizers

1 Refer to Confirmatory Soils Testing and Amending in Section 32 9113 – Soil Preparation for these items.

D Chemicals, Insecticides, and Fungicides for plant disease or pest control

1 If required due to plant disease and pests, only those persons licensed to use these in State where this project is being built shall apply these.

2 Use only those accepted for use by meeting all applicable Local, State and Federal laws and regulations.

3 Best quality materials with original manufacturers' containers, properly labeled with guaranteed analysis.

4 Use non-staining materials.

5 A record of all herbicide applications done, the herbicide used and how much applied shall be kept by the Contractor and submitted at the end of the (1) year Warranty for Plants, Lawns and Meadows.

6 Protect adjacent plant and grasses when herbiciding. Any plants which are killed or damaged in the opinion of the Landscape Architect shall be replaced by the Contractor to match those plants damaged. Remove damaged plant and dispose of legally off site.

E Groundcovers, Perennials and Bulbs: Match accepted materials Nursery-grown in pots, full, healthy plants. Annuals shall be in the same flowering state as those remaining in healthy condition.

F Lawns and Grass Mixes: Match accepted materials.

G Landscape soil (s) and backfill mix(s): Match Accepted Materials for lawns and Grasses and Plants. Refer to Section 32 9113 Soil Preparation.

H Mulch: Match the accepted material. Refer to Section 32 9000 – Planting.

2.02 Replacement Plants and Lawn and Grasses

A Match approved Plants and Lawn and Grass Seed Mix(s).

2.03 EQUIPMENT

A General: Use only the proper tool for each job. Maintain all tools in sharp, properly-functioning condition. Clean and sterilize pruning tools prior to usage.

B Insect/Disease Prevention: Take all measures to prevent introduction of insect or disease-laden materials onto the site. Planting - Section 32 9000.

PART 3 – EXECUTION

3.01 REMOVAL, REPAIR AND REPLACEMENT OF DAMAGED WORK

A Remove, repair and replace any work in Section 31 1320 - Existing Plants to Remain, Section - 32 9200 - Lawns and Section 32 9000 - Planting or any of the Owner's Existing Property or any Work in the Contract which has been damaged by Maintenance work to match the requirements of the damaged work at no additional cost to the Owner.

3.02 PLANTING MAINTENANCE PREPARATION

A Protection:

1 Protect all new planting areas from damage of all kinds from beginning of work until the Acceptance of the 90 Day Maintenance.

2 Provide temporary protection fences, barriers and signs as required for protection.

B Replacements

1 Immediately treat or replace all plants which become damaged or injured as a result of Contractor's operations or negligence, as directed by Landscape Architect, at no cost to Owner.

2 Replacement plants shall match size, condition and variety of plants replaced.

C Repair any damage done as a result of any maintenance work to Lawns or the Work of any other Section of the Specification to match the work specified therein.

3.03 INSECTS, PESTS, AND DISEASE CONTROL

A Inspection: Inspect all plant materials for signs of stress, damage and potential trouble from the following:

1 Presence of insects, moles, gophers, ground squirrels, snails and slugs in planting areas.

2 Discolored or blotching leaves or needles plant diseases and insect infestation.

a Unusually light green or yellowish green color inconsistent with normal green color of leaves.

B Personnel: Only licensed, qualified, trained personnel shall perform spraying for insect, pest and disease control.

C Application: Spray with extreme care to avoid all hazards to any person or pet in the area or adjacent areas.

3.04 PLANTING MAINTENANCE FOR TREES, SHRUBS AND VINES

A Watering

1 Water shall be applied by the Contractor in sufficient quantities to keep the plants in a healthy thriving condition. Care shall be taken not to over water plants.

2 Watering Basins

a Maintain all watering basins around plants so that enough water can be applied to establish moisture through major root zones.

b For supplemental hand watering of watering basins, use a water wand to break the water force. Do not permit use of "jet" type watering equipment. Do not permit crown roots to become exposed to air through dislodging of soil and mulch.

c Maintain originally called for depth of mulch to reduce evaporation and frequency of watering.

d In rainy season, open basins to allow surface drainage away from the root crown where excess water may accumulate. Restore watering basins at end of rainy season.

3 The Contractor shall review the plant rootballs and adjacent soil(s) and the plants for watering requirements and deficiency or excessive watering symptoms.

a If sufficient water is found to be retained in the plants rootball, and/or adjacent soil, the watering may be reduced.

1) The Contractor shall excavate and examine the rootballs and adjacent soil(s) with an acceptable moisture sensing device designed for this purpose and also make his own professional review and additional sampling and testing as necessary to determine the adequacy of the watering.

b The Contractor shall also review the plants for determination of over or under watering needs and symptoms.

B Resetting: Reset plants to proper grades and upright position using the specified materials.

C Weed Control

1 All areas between plants, including plant beds and watering basins, shall be weed free at all times.

2 Avoid frequent soil cultivation that destroys shallow roots.

D Tree and Shrub Pruning: All persons performing pruning operations shall possess a current Arborist License or be directly supervised by and individual who does for the state in which this project is located.

1 Prune trees and shrubs to select and develop permanent scaffold branches that are smaller in diameter than the trunk or branch to which they are attached. In reference to trees, prune branches that have vertical spacing of 18 in. to 48 in. and radial orientation so as not to overlay onto one another.

2 Prune trees and shrubs to eliminate diseased or damaged growth, and narrow V-shaped branch forks that lack strength. Reduce toppling and wind damage by thinning out crowns.

3 Prune trees and shrubs to maintain growth within space limitations, maintaining a natural appearance and balancing crown with roots.

4 No stripping of lower branches ("raising up") of young trees or shrubs will be permitted.

5 Retain lower branches in a "tipped back" or pinched condition to promote caliper trunk growth (tapered trunk). Do not cut back to fewer than six buds or leaves on such branches. Only cut lower branches flush with the trunk after the tree is able to stand erect without staking or other support.

6 Thin out and shape evergreen trees when necessary to prevent wind and storm damage. Do primary pruning of deciduous trees during the dormant season. Do not permit any pruning of trees prone to excessive "bleeding" during growth season.

7 Prune damaged trees or shrubs or those that constitute health or safety hazards at any time of year as required.

8 Make all cuts clean and close to the trunk, without cutting into the branch collar. "Stubbing" will not be permitted. Cut smaller branches flush with trunk or lateral branch. Make larger cuts (1 in. in diameter or larger) parallel to shoulder rings, with the top edge of the cut at the trunk or lateral branch.

9 Branches too heavy to handle shall be precut in three or more stages to prevent splitting or peeling of bark. Make the first two cuts 18 in. or more from the trunk to remove the branch. Make the third cut at the trunk to remove the resulting stub.

10 Do not prune or clip shrubs into balled or boxed forms unless specifically called for by design.

11 Hedge Pruning – Review plants that are noted in the plant list to be pruned into hedges with the Landscape Architect for shaping requirements.

12 Take extreme care to avoid transmitting disease from one infected plant to another. Properly sterilize pruning tools before going from one infected plant to all other plants.

E Remove all vine stakes and ties at the completion of the warranty period.

F Plant Disease(s)

1 Treat any plants which are diseased.

a If the plants which are diseased do not respond to treatment in the opinion of the Landscape Architect, they shall be removed and replaced with matching healthy plants , at no Additional cost to the Owner.

G Shovel Cut Bed Edging: Redo as necessary to keep shape.

H Remove all dead plants immediately. Replace as soon as possible within the planting season.

I Mulch: Apply mulch as necessary to restore beds to accepted condition.

J Plant fertilization and amending: apply fertilizers and amendments as provided per Confirmatory Soils Testing and Amending in Section – 32 9113 – Soil Preparation.

3.05 GROUNDCOVER'S MAINTENANCE

A Water to maintain the plants in a healthy and flourishing condition.

B Watering

1 Check for moisture penetration throughout the root zone at least twice a month and more frequently as weather conditions require.

2 Water as frequently as necessary to maintain healthy growth of groundcovers.

C Weed Control

1 Control weeds and remove all weeds.

2 Minimize hoeing of weeds in order to avoid plant root damage.

D Fertilization

1 Do not use fertilizers unless soil test shows specific nutrient deficiencies.

a Notify the Landscape Architect of any soil testing need for review and approval prior to testing.

1) Sampling and testing shall be as specified in Section 32 9113 Soil Preparation unless otherwise required by the Landscape Architect.

E Edging

1 Edge groundcovers to keep in bounds. Trim top growth as necessary to achieve an overall even appearance.

2 Shovel Cut Bed Edging: Redo as necessary to keep shape.

F Remove dead plants immediately and replace dead or missing plants as soon as possible within the planting season.

G Plant Disease(s)

1 Treat any plants which are diseased.

a If the plants which are diseased do not respond to treatment in the opinion of the Landscape Architect, they shall be removed and replaced with matching healthy plants , at no Additional cost to the Owner.

H Mulch: Apply mulch as necessary to restore beds to accepted condition.

3.06 LAWN AND GRASSES MAINTENANCE UNTIL ACCEPTANCE OF THE 90 DAY MAINTENANCE PERIOD

A Watering

1 Watering for all lawns and meadows shall be daily for the first week after installation unless site or weather conditions require adjustment of watering or as directed by the Landscape Architect.

2 General Watering: Water lawns and meadows at such frequency as weather conditions require to replenish soil moisture and keep the lawns and Grasses in a flourishing thriving condition (including the period before the irrigation is activated and accepted).

3 Care shall be taken not to over water lawns since adjacent plants or plants in lawn areas might be damaged by over watering.

B Weed Control

1 Control broadleaf weeds and remove.

2 Lawns: Control and remove all crabgrass and weeds and replace and rehydroseed lawn areas within the specified planting season(s).

3 Control thatch buildup of lawns, but not the Meadows or Detention Basin.

C Mowing

1 Hydroseeded Lawns and Athletic Field Cultipactor seeded areas

a The first mowing shall take place when the grass is (4) inches tall and shall result in a height of (3) inches tall.

b Subsequent mowing shall take place when the grass is (4) inches tall. The final cut height shall be no lower than (2-1/2) inches tall.

c Each cutting shall result in a stand of evenly mowed grass. Immediately following cutting, neatly trim around all interfaces such as walls, signs, plant beds etc

1) Do not girdle trees with weed wackers or other trimmers.

d Mowing along Shrub and Groundcover bed edges: Shovel cut or mechanically trim lawn bed edges at least twice a month or as needed for neat appearance. Vacuum clippings and dispose legally off site.

D Fertilization and Amending of Hydroseeded Lawn and Athletic Fields

1 Apply fertilizers and amendments as provided per Confirmatory Soils Testing and Amending in Section 32 9113 – Soil Preparation.

2 Apply fertilizer when grass is dry and preferably after mowing. Do not apply during hot weather or when grass is under stress. Water immediately after application.

E Plant Disease(s)

1 Treat any plants (grasses) which are diseased.

a If the plants which are diseased do not respond to treatment in the opinion of the Landscape Architect, they shall be removed and replaced with matching healthy plants, at no Additional cost to the Owner.

F Replace any damaged, washed out or diseased hydroseeded lawns and Athletic Fields Grass, Meadow Grass, and Detention Basin Grass areas with the specified grasses for the areas.

3.07 MULCH AREAS MAINTENANCE

A Replace any disturbed mulch immediately.

3.08 CLEAN UP

A Dispose of all pruned materials, vacuum all lawn clippings and leaves, sweep all walkways and rake smooth all mulch areas.

B Remove from the site all containers and evidence of maintenance activities.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Site Clearing.

2. Topsoil Stripping.

3. Clearing and Grubbing.

4. Protection and Abandonment of Utilities

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 02 41 00 – DEMOLITION for items to be demolished.

2. Section 31 20 00 – EARTH MOVING for soil materials, excavating, backfilling, and site grading and removal of site utilities.

3. Section 31 25 00 – EROSION AND SEDIMENTATION CONTROLS for required erosion and sedimentation control measures.

1.03 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

PART 2 – PRODUCTS

(Not applicable to work of this section.)

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

3.2 SITE CLEARING

A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions, except for those indicated on the Contract Drawings to remain, interfering with installation of new construction. Remove such items elsewhere on site or premises as specifically indicated. Removal includes digging out stumps in their entirety and grubbing roots to at least 30 inches below existing grades shown on the Contract Drawings.

B. Carefully and cleanly cut roots and branches of existing trees indicated to remain and be protected, where such roots and branches obstruct new construction. Use only hand methods for grubbing inside drip line of trees indicated to be left standing.

3.3 DISPOSAL OF WASTE MATERIALS

A. Removal from Owner's Property: Remove waste materials and unsuitable and excess topsoil and dispose of offsite in a legal manner. Waste materials shall include but not be limited to timber, brush, refuse, stumps, roots, vines, debris and other objectionable matter. All timber designated in the field by the Owner's Representative to not be disposed of by the Contractor shall be stored at a nearby location for ultimate disposal by the Owner. Timber to be stored shall be de-branched, cut into six-foot lengths and stacked as directed.

1. Burning of cleared and grubbed materials, or other fires for any reason will not be permitted.

2. No rubbish or debris of any kind shall be buried on site.

3.4 STRIPPING (REMOVAL) OF TOPSOIL

A. Topsoil shall be carefully removed, to the depths directed, over all areas which are shown on the Contract Drawings to be excavated and/or filled, and over all other areas to be disturbed as a result of the Contractor's operations in the performance of the Contract work. The topsoil shall be transported and deposited in storage piles convenient to the areas, which are subsequently to receive the application of topsoil, separate from other excavated materials and in approved locations. The topsoil shall be stockpiled free of roots, stones and other undesirable material. The Contractor shall take all necessary precautions to prevent other excavated material or other objectionable material from becoming intermixed with the topsoil, either before or after the stripping and stockpiling operations. Stripping operations shall be completed prior to the start of excavation, trenching, or grading operations.

B. The Contractor shall take reasonable care to avoid creating unsightly or unsafe conditions and to avoid unnecessary damage or injury to surroundings.

3.5 STOCKPILING

A. The Contractor is responsible for all construction, protection, movement, and maintenance of stockpiles. Stockpiles shall be neatly trimmed and graded to provide proper drainage from their surfaces and maintained so as not to erode or pollute their surroundings.

3.6 EXCESS TOPSOIL

A. Topsoil which has been stripped and stockpiled, but is not needed after the completion of all final topsoil and grassing shall be disposed of offsite.

3.7 PROTECTION

A. Trees and other vegetation designated to remain shall be protected from damage by construction operations by erecting barriers, guards or enclosures. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain, damaging the work being constructed, and to provide for the safety of employees and others.

B. Maintain the protection until all work in the vicinity of the work being protected has been completed.

C. Do not operate heavy equipment or stockpile materials within the branch spread of existing trees to remain.

D. Immediately repair any damage to existing tree crowns, trunks, or root systems. Roots exposed and/or damaged during execution of the work shall immediately be cut off cleanly inside the exposed or damaged area. Treat cut surfaces with a tree wound paint and spread topsoil over the exposed root area.

E. When work is completed, remove all dead and downed trees. Live trees shall be trimmed of all dead and diseased limbs and branches. All cuts shall be cleanly made at their juncture with the trunk or preceding branch without injury to the trunk or remaining branches. Cuts over 1-inch in diameter shall be treated with tree wound paint.

F. Restrict construction activities to those areas within the limits of construction, public rights-of-way, and easements designated on the Contract Drawings. Adjacent properties and improvements thereon, public or private, which become damaged by construction operations shall be promptly restored at the Contractor's expense to their original condition, and to the full satisfaction of the property owner.

3.08 SITE UTILITIES

A. The Contractor is responsible for coordinating and scheduling with the authorities having jurisdiction the removal and/or abandonment of existing gas, telephone, cable, and electric services, as required to complete the work.

B. Utility pipes to be abandoned shall be plugged at their ends with watertight brick masonry or cement mortar with a minimum thickness of 8 inches. Utility pipes designated to be removed shall include backfilling the voids with ordinary borrow.

C. All utility pipes designated to be abandoned and left in-place when cut or interrupted by new work shall be plugged at their ends. Plugs shall be watertight brick masonry or cement mortar with a minimum thickness of 8 inches.

D. Utility structures designated on the Contract Drawings to be removed shall consist of the removal and stacking of cast iron castings, plugging of inlet and outlet pipes, removal of the structure, and backfill and compaction of the void with ordinary borrow. When the void is within the footprint of the new building, gravel borrow shall be used to backfill the void.

E. Utility structures to be abandoned in place shall have their cast iron castings removed and disposed, inlet and outlet pipes plugged, the bottom of the bottoms shall be broken, the void of the

structure shall be backfilled and compacted with ordinary borrow and the top of the structure shall be removed so that it is at least 30" below finished grade.

END OF SECTION 31 10 00

SECTION 31 1320

EXISTING PLANTS TO REMAIN

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide transplanting, storage, protection, pruning, fertilization, root pruning and other care which may be required of all EXISTING TREES and SHRUBS within the Protection Fence Areas where shown on the Plans and as specified herein.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Demolition – Division 02 4100
2 Site Preparation – Section 31 1000
3 Earthwork - Section 31 2000
4 Soil Preparation - Section 32 9113
5 Planting - Section 32 9000
6 Landscape Maintenance - Section 31 0125

1.04 PROJECT CONDITIONS

A Review: Visit and walk the site with the Owner's representative to clarify scope of work and understand project conditions.

B Documentation: Confirm location of all trees within the areas to be protected. Record all discrepancies and all conditions, which threaten existing plantings.

1.05 DEFINITIONS

A Protection: Provide repair to all barricades as required to prevent all damage to existing plant materials to remain, including but not limited to protection from mechanical damage, and soil compaction, pollution from all sources, and disruption of environmental support which would result in the loss of vigor of the Trees and Shrubs

B Protected Area: Areas on the plan protected by Construction Fencing, Silt Fencing, Hay Bales and Protection Fencing.

C Arborists: Person certified and licensed in the State of Massachusetts in the care of plant materials and application of chemicals.

D References to Landscape Architect shall mean Architect or the Architect's designated representative.

1.06 PERIOD OF PERFORMANCE

A From Award of Contract to Final Acceptance For Landscape Planting One Year Warranty. Refer to Section 31 0125 – Landscape Maintenance.

1.07 QUALIFICATIONS

A The Arborist shall be licensed and certified Arborist in the State of Massachusetts with a minimum of (10) years of experience in the care of large trees during the construction process.

1.08 SCHEDULING

A Note that this is a phased project and that work required in this section may need to be installed and maintained out of sequence.

B Construct Protective Barriers and perform other methods as shown on the drawings and as recommended by the Arborist.

1.09 WARRANTY

A Existing Trees and Shrub Warranty:

1 General: Similarly warrant all EXISTING TREES AND SHRUBS which are within the Protected Area, trees to be transplanted and trees to be stored that are part of the work to be protected against decline resulting from damage and or lack of watering during construction until Final Acceptance of the new planting to be installed.

B Damaged or Dead Existing Tree and Transplanted Tree Replacement Tree(s) Warranty

1 The Warranty shall be the same as for new trees and shrubs. See Section 32 9000 Planting

C Exclusions: Damage due to vandalism, Acts of God, or neglect by Owner.

1.10 REPLACEMENT OF DAMAGED EXISTING TREES AND SHRUBS

A Replacement of Existing Trees to be Protected, Transplanted and Stored: Existing trees to be protected, transplanted and stored which exhibit conditions which are determined by the Landscape Architect as unacceptable due to inadequate protection and or watering during construction shall be removed (including stumps and roots), disposed, and replaced and warranted (the same as for new planting) by Contractor at no expense to Owner.

B Replacement trees shall be the same species as the damaged tree.

C Replacement Tree Schedule:

1 Deciduous trees 10" caliper and over: Replace with (1) 9” to 10” cal. B&B specimen trees per damaged tree. The locations and type of tree shall be chosen by the Landscape Architect.

2 Deciduous trees 10" caliper and less: Replace with (1) B&B specimen tree of the same caliper per each damaged tree. The locations and type of tree shall be chosen by the Landscape Architect.

3 Evergreen trees 14’ tall over: Replace with (1) 14’ tall B&B specimen trees per damaged tree. The locations and type of tree shall be chosen by the Landscape Architect.

4 Evergreen trees 14’ and less: Replace with (1) B&B specimen tree of the same height per damaged tree. The locations and type of tree shall be chosen by the Landscape Architect.

5 Memorial Tree: Replace wih (1) B&B specimen tree of same size and species as approved by the Landscape Architect.

D REPLACEMENT SHRUB SCHEDULE

1 Shrubs: Replace with (1) B&B specimen shrub per damaged shrub at the same size as the damaged or dead shrub. The location and species shall be chosen by the Landscape Architect.

E Replacement Trees and Shrubs shall be considered new trees and all applicable requirements as for trees and shrubs are as specified under Planting and all the related sections.

1.11 ACCEPTANCE OF EXISTING PLANTS TO REMAIN AND ANY REPLACEMENT PLANTS

A Acceptance Requirements: For Preliminary Review, 90-Day Maintenance Period, and Final Acceptance, See Section 31 0125 - Landscape Maintenance.

1.12 SUBMITTALS AND SAMPLES

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Resume of qualified Arborists including a list of similar projects of the licensed and certified Arborist that the Contractor proposes to use on the project.

C Field Report on the condition of the Existing Trees and Shrubs, including means, methods and schedule for care, before Construction begins on the site.

D Submit off site location for stored Memorial Tree.

E Report by the Arborist on the condition and care of the Trees and Shrubs within the project site and the any stored trees.

1 Report Frequency: First week and third week of each month (twice per month) for the months of April, May, June, July, August, September, October and

November. Second week of each month (one per month) for the months of November, December, January and February.

2 Evaluation on the condition of each tree and shrub area.

3 Recommendation for care to be undertaken by the Contractor due to stress, encroachment into the Protected Area by vehicles, foot traffic or stored materials.

4 Recommendations for movement of Protection Fencing and for care for trees and shrub areas in preparation for construction in the area of tree protection.

5 Tree and Shrub evaluation, reports, pruning, fertilization, watering and other means and methods required to be completed by the Contractor during Construction to preserve Existing Trees and Shrubs, shall be provided by the Contractor at no cost to the Owner.

6 Temporary Tree Irrigation:

a Drawing indicating temporary and automatic irrigation system including but not limited to irrigation piping, irrigation heads, timer, pipe connections to the water source and any other equipment necessary to water the trees at intervals recommended by the arborist and/or Landscape Architect.

F Submit (1) pound of pine bark mulch.

PART 2 – PRODUCTS

2.01 FERTILIZERS, HERBICIDES AND PEST CONTROL: As recommended by the Arborists and acceptable to Federal, State and Local authorities.

2.02 PROTECTION FENCING

A Temporary chain link fencing which shall have a 9 gauge mesh and be 6'-0" high above the ground (Salvaged chain link fencing may be used). Line posts shall be 2" o.d. steel pipe. Provide hardware as required for attaching fence. All fabric shall be knuckled selvage.

1 If posts are on paved areas, provide footings which will stabilize fence and not damage paving.

2.03 MULCH:

A Type: Wood chip mulch as recommended by the Arborist.

2.04 TEMPORARY TREE IRRIGATION

A Provide materials acceptable to the Landscape Architect.

2.05 SAFETY: Provide all reflective signage and/or flashers as required by all codes and ordinances affecting protected plantings to remain.

PART 3 – EXECUTION

3.01 PROTECTION FENCE ERECTION

A Install where shown on the Drawings and adjust as needed to accommodate working conditions. Post shall be a maximum of 6’-0” on center.

B Drive posts 3'-0" into ground leaving 6'-0" exposed.

C Stretch and install fabric leaving approximately 1" inch between finish grade and the bottom selvage. Pull fabric taut and tie to posts.

D Maintain the fence in a true, upright and secure alignment

E Remove when directed by the Landscape Architect.

3.02 OPERATIONS

A Storage: Do not store materials or equipment under the branches of all existing trees to remain.

B Traffic: Do not operate nor park equipment within the drip line of existing trees to remain. Keep foot traffic out of existing planted areas.

3.03 TREE TRANSPLANTING

A Dig and Transplant trees that area located on the site and indicated on the plans to the location as indicated on the plans.

1 Tree shall be properly dug with firm, natural balls of soil retaining as many fibrous roots as possible, in sizes and shapes as specified in the *American Standard for Nursery Stock*. Balls shall be firmly wrapped with nonsynthetic, rottable burlap and secured with nails and heavy, nonsynthetic, rottable twine. The root collar shall be apparent at surface of ball. An approved Mechanized Tree Spade may be used. The tree spade shall move trees limited to the maximum size allowed for a similar B&B root-ball diameter according to the *American Standard for Nursery Stock* or the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller. The machine shall be approved by the landscape architect prior to use. Trees shall be planted in accordance with applicable sections of the specifications.

2 Immediately after a tree is dug, it must be replanted where shown on the drawings. Rootballs shall be checked regularly and watered sufficiently to maintain root viability.

B Transportation and Storage of Plant Material

1 Branches shall be tied with rope or twine only, and in such a manner that no damage will occur to the bark or branches.

2 During transportation of plant material, the contractor shall exercise care to prevent injury and drying out of the trees. Should the roots be dried out, large branches broken, balls of earth broken or loosened, or areas of bark torn, the landscape architect may reject the injured tree(s) and order them replaced at no additional cost to the owner. All loads of plants shall be covered at all times with tarpaulin or canvas. Loads that are not protected will be rejected.

3 Plants must be protected at all times from sun or drying winds.

C Planting: Refer to Planting – Section 32 9000.

D Warranty: The Warranty shall be the same as for new trees and shrubs. See Section 32 9000 Planting

3.04 PROTECTION OF EXISTING TREES, SHRUBS AND STORED TREES

A Protect existing trees and shrubs and other associated vegetation to remain in place, against unnecessary cuttings, breaking or skinning of roots, skinning or bruising of bark, smothering of tree roots by stockpiling construction materials within drip line. Protect vegetation from excess foot traffic, vehicular traffic or parked vehicles within the drip line.

B During construction, all recommendations for care of the Existing Trees and Shrubs to Remain by the Arborist and Approved by the Landscape Architect, shall be performed to assure the health and vigor of the trees at no cost to the Owner.

C Water the trees to be protected as required to maintain their health during the course of construction operations.

D Trees and Shrubs damaged by construction operations which are scheduled to remain.

1 Repair trees and shrubs that are damaged by construction operation in a manner acceptable to the Arborist and Landscape Architect. No roots greater than 2" inches in diameter shall be cut from plants to remain without the prior approval. Provide protection for roots over (1) inch diameter during construction operations by installing a (2) inch layer of mulch.

2 Prune roots that are either cut or broken with a smooth clean cut. Temporarily cover exposed roots with wet burlap to prevent roots from drying out, cover with earth as soon as possible.

3 Replace trees and shrubs damaged beyond repair, as determined by the Landscape Architect. Replacement of trees and removal and disposal of damaged material shall be at the Contractor's expense.

a Refer to REPLACEMENT OF DAMAGED EXISTING TREES as specified in Part 1 of this Section.

4 Trees and shrubs damaged beyond repair as determined by the Landscape Architect shall be removed immediately.

5 Replacement trees and shrubs shall be planted as soon as weather conditions permit and within the specified planting season.

3.05 MULCH LAYER

A Install a (6) inch deep maximum layer of wood chip mulch in areas designated during construction. Remove mulch upon completion of construction and install materials as indicated on the drawings or a (2) inch layer of bark mulch if a material is not indicated on the drawings.

3.06 EXCAVATING AND GRADING IN TREE AND SHRUB PROTECTED AREAS

A Cutting: Do not permit machine excavation within the Protected Area. All such work shall by hand labor unless otherwise authorized by the Landscape Architect.

B Filling: Do not permit stockpiling of soil within the Protected Area.

3.07 REPLACEMENT PLANTS FOR DAMAGED EXISTING PLANTS

A All replacement plants shall be considered new plants and all applicable planting details and specification requirements shall apply.

3.08 MAINTENANCE OF TRANSPLANTED AND PROTECTED TREES

A General: During the Maintenance Period for new planting, similarly maintain all protected trees. See Section 32 9113 - Landscape Maintenance.

1 Add mulch as necessary to replace washed or otherwise depleted mulch areas and as required by the Landscape Architect..

3.09 PRUNING OF EXISTING TREES DESIGNATED TO REMAIN

A In addition to the pruning shown on the drawings, carry out pruning as specified and as directed on site by the Architect, using the crew and equipment specified below for four (4) days of eight (8) hours each on the job site (travel time not included):

1 One (1) foreman (to be a certified arborist).

2 Three (3) laborers.

3 Aerial lift (to 25 foot height).

4 Truck (20 cy capacity).

5 Chipper.

6 Small tools, to include two (2) chainsaws.

B Pruning and trimming are generally described as the removal and disposal of limbs, branches and stubs which are either dead, decayed, diseased, dying, broken, weak, low hanging, rubbing, contacting structures, potentially detrimental to the health of the tree or dangerous to pedestrians, visually deficient, interfering or otherwise objectionable as determined by the Architect.

C This Contractor shall leave the work site at the end of each working period in a condition satisfactory to the Architect. All trimming or any other form of debris shall be removed

from the work site and legally disposed by this Contractor, and the areas swept clean of all material related to the work operation.

D This Contractor shall adhere to the specifications and provide suitable facilities for inspecting the work. Failure of the Architect to immediately reject unsatisfactory work or to notify this Contractor of his deviation from the specification shall not relieve this Contractor of his responsibility to correct or remedy unsatisfactory work.

E All pruning shall be performed in a manner which maintains the natural aesthetic characteristics of the species and varieties of trees. No topping or dehorning of trees or stubbing back of branches shall be permitted. All cuts will be made to a lateral branch a minimum of one third the size of the branch being removed, unless otherwise instructed by the Architect.

F The use of climbing spurs or spike shoes shall not be permitted.

G All cuts shall be made sufficiently close to the parent stem so that wound closure can be readily started under normal conditions. However, cuts shall never be made through the branch collar. Slab cuts and rip cuts shall never be made.

H All pruning performed on this project shall include the provision of proper clearance from all luminaries and proper elevation over street and sidewalk surfaces to at least the following minimum specifications:

1 Luminaries - Any and all branches extending directly below a street luminary as to limit the light reaching the street or path shall be removed and all branches shall be cut back to afford a minimum of four (4) feet of clearance on all sides of all luminaries.

2 Sidewalks/Roads - All branches shall be pruned to allow a minimum eight (8) foot clearance over sidewalk surfaces and ten (10) foot clearance over roadways.

I All limbs over two inches in diameter to be removed shall be pre-cut to prevent splitting. Lower to the ground by proper ropes any branches that would by falling injure the tree and other objects.

J Remove one of the two crossed or rubbing branches, where practical, so that the removal will not leave large holes in the general outline of the tree.

K On trees known to be diseased and where there is known to be danger of transmitting the disease on tools, tools are to be disinfected with alcohol after each cut between trees. Such trees are to be identified prior to pruning for the Architect, who may direct that the tree be removed instead.

L Pruning shall be performed in accordance with the National Arborists Association Pruning Standards for Shade Tree Class II (below). The scope of work shall otherwise be as directed in the field by the Architect.

M Class II - Medium pruning shall consist of the removal of dead, dying, diseased, interfering, objectionable, unsightly, and weak branches on the main trunks as well as those within the leaf area to the full height of affected trees. An occasional branch up to

one (1) inch in diameter may remain. The presence of any structural weakness, disease conditions, decayed trunk or branches, split crotches or branches should be reported in writing to the Architect.

N Lateral branches as well as occasional branch suckers may be retained. Complete removal of secondary laterals and branch suckers resulting in the stripping of major limbs (turkey tailed) will not be permitted.

O The Contractor shall only work on trees designated to remain and to be pruned within the limit of work indicated on the Sitework Drawings, or trees which otherwise affect the work of this Contract. No compensation shall be made for work performed on any other tree.

P If the Contractor discovers tree(s) which have been designated for pruning, but whose condition is such that removal is warranted, whether due to death, disease, decay or structural weakness, such tree(s) shall not be pruned and the Contractor shall immediately report his findings in writing to the Architect before any work is done at such particular tree(s) in question.

3.10 CLEAN UP

A Repair all grades and remove all debris, stumps, plants, trees and shrubs and excess material and legally dispose off site.

B Remove all temporary tree irrigation materials and equipment and legally dispose off site.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

Geotechnical engineer should review this specification.

PART 1 – GENERAL

1.01 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Excavation of all types.

2. Sheeting, shoring and dewatering of trenches and excavations.

3. Providing, placing, and compacting fill materials.

4. Removal, hauling, stockpiling, rehandling, and placement of materials.

5. Off-site disposal of excess or unsuitable materials.

6. Rough grading.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 311000, Site Preparation for site clearing and preparation.

2. Section 312500, Sedimentation and Erosion Control for erosion and pollution control.

1.03 SUBMITTALS AND TESTING

A. Refer to Division 1 General Requirements for submittal provisions and procedures.

1. Backfill Materials: Submit 50 pound sample for each backfill material from each proposed source including on-site materials. Submit a grain size analysis and distribution curve performed in accordance with ASTM D422 for each proposed backfill material for review by the Engineer. Additional samples and analysis shall be submitted if a change in material occurs at the borrow source.

2. Excavation and Excavation Support Plan: Submit at least 10 calendar days prior to the start of the work a detailed plan for the sequence of excavation, and methods to be used for excavation support and dewatering of excavations. Submit engineering calculation stamped by a Massachusetts Registered Professional Engineer and shop drawings for earth support systems to be used. Dewatering and groundwater control systems shall be designed to keep excavations free of water and to avoid disturbance of the subgrade.

3. Moisture-density curve indicating the maximum dry density and optimum moisture content as determined by ASTM D1557 for each proposed source of backfill.

4. Filter fabric: Submit the manufacturer's information and a one square foot representative sample of the filter fabric.

5. Within one week after making field adjustments, resubmit revised working drawings as necessary to reflect changes required by field conditions.

6. Obtain required permits for discharge of dewatering effluent. Submit two copies of all permits obtained at least one week prior to system installation.

7. A Soils Engineer/testing laboratory shall make such tests of materials and samples as necessary to insure materials and compaction requirements are achieved and as directed by the Owner's Representative. Costs for such tests shall be borne by the Contractor. Submit daily field reports from the geotechnical testing laboratory documenting all Earth Moving activity and field testing for each day. The field reports shall include as a minimum the following:

   a. A description of the day's activities.

   b. The results of in-place density testing including in-place dry density, moisture content, percent compaction, elevation of test and a description of the soil.

   c. A sketch indicating the extent of each day's work and the location of testing.

8. Submit the qualifications of the independent geotechnical testing laboratory performing soil testing and inspection services during Earth Moving operations. The geotechnical testing laboratory must demonstrate that it has the experience and capability to conduct required field and laboratory geotechnical testing.

1.04 REFERENCE STANDARDS

A. The following standards are applicable to the work of this section to the extent referenced herein.

   1. ASTM: American Society for Testing and Materials.

1.05 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.06 SUBSURFACE CONDITIONS

Reference available subsurface data and reports.

1.07 EXCAVATION CLASSIFICATIONS

A. Earth Excavation or "Excavation" consists of removal of materials encountered to the subgrade elevations indicated and subsequent reuse or disposal of the materials removed. All excavation is classified as earth excavation unless it otherwise meets the classifications provided below for unauthorized excavation, additional excavation, or rock excavation.

B. Unauthorized Excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Owner's Representative. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.

1. Under footings, foundations, concrete slabs, retaining walls or other structures, fill unauthorized excavations to the proper elevations with gravel borrow. Elsewhere, backfill and compact unauthorized excavations as specified for excavations of the same class, unless otherwise directed.

C. Additional Excavation:

1. When excavation has reached required subgrade elevations, notify the Owner's Representative who will review subgrade conditions.

2. If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace excavated material as directed.

3. Removal of unsuitable material and its replacement as directed will be paid on the basis of contract conditions relative to changes in work or as provided for under the unit rates for this classification.

D. Rock Excavation:

1. Rock excavation in trenches includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42-inch wide bucket on medium-size track-mounted hydraulic excavator equivalent to Caterpillar Model 215, rated at not less than 90HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10-feet in width are classified as open excavation.

2. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty hydraulic excavating equipment without drilling or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170HP flywheel power and developing 40,000-lb. breakout force (measured in accordance with SAE J732C). No blasting is allowed on site.

3. Determination of rock excavation classification will be made by the Owner's Representative. Typical of materials classified as rock are boulders 3.0 cubic yards or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits. Intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by the Owner's Representative. Visual observation of the completed excavation may be made by the Owner's Representative to modify the excavation classifications. Removal of rock excavation prior to classification by the Owner's Representative shall be considered as earth excavation unless accepted by the Owner's Representative in writing. Such excavation will be paid on the basis of contract unit rates for this classification.

4. Rock payment lines (if applicable) are limited to the following:

a. Two feet outside of concrete work for which forms are required.

b. One foot outside of the vertical walls of utility structures.

c. In pipe trenches, depth limits shall be 6 inches below the bottom of the pipe:

Depth From Ground Surface to Invert of Pipe	Pay Width (Pipe ID)	
	0-24"	Over 24"
0 to 12'	5'-0"	Pipe I.D. +3'-0"
12' to 20'	7'-0"	Pipe I.D. +7'-0"
Over 20'	9'-0"	Pipe I.D. +7'-0"

d. Rock sloping across the width of trench shall have the top of rock established at the rock elevation over the centerline of the pipe.

1.08 EXCAVATION

A. The Contractor shall perform all excavations and of whatever materials encountered, in a manner as required to allow for placing of temporary earth support, forms, installation of pipe and other work, and to permit access for the purpose of observing the work. Excavations shall be to such widths as will give suitable space for the required work. Bottoms of trenches and excavations shall be protected from frost and shall be firm, dry and in an acceptable condition to receive the work. Work shall not be placed on frozen surfaces nor shall work be placed on wet or unstable surfaces.

B. All excavations made in open cut will be controlled by the conditions existing at that location. In no case shall earth be excavated or disturbed by machinery so near to the finished subgrade for structures and pipelines as to result in the disturbance of the earth below the subgrade. The final excavation to subgrade should be accomplished with a smooth faced bucket or by hand.

1.09 TEMPORARY EARTH SUPPORT

A. The Contractor shall furnish, place and maintain such sheeting, shoring, and bracing at locations necessary to support the sides of excavations to prevent danger to persons or damage to adjacent pavements, facilities, utilities, or structures; to prevent injurious caving or erosion or the loss of ground; and to maintain pedestrian and vehicular traffic as required by the Contract Documents, the Contractor's sequence of construction, and as directed by the Owner's Representative.

B. In all sheeting, shoring and bracing operations, care shall be taken to prevent collapse of excavations, injury to persons or damage to adjacent structures, facilities, utilities and services. Any injuries to persons shall be the responsibility of the Contractor; and any damage to the work occurring as a result of settlement, water or earth pressure, or other causes due to inadequate bracing or other construction operations of the Contractor shall be satisfactorily repaired and made good by the Contractor, at no additional expense to the Owner.

C. Where sheeting is to be used, it shall be driven ahead of excavation operations to the extent practicable so as to avoid the loss of material from behind the sheeting; where voids occur outside of the sheeting, they shall be filled immediately with ordinary fill, thoroughly compacted.

D. The Contractor shall leave in place all sheeting and bracing at the locations and within the limits ordered by the Owner's Representative in writing. The Contractor shall cut off the sheeting at elevations as indicated on the Contract Drawings or to be determined with the approval of the Owner's Representative.

E. The Contractor shall comply with all federal, state, and local safety regulations, and requirements.

1.10 GROUNDWATER CONTROL

A. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property.

B. Any damage resulting from the failure of the dewatering operations of the Contractor, and any damage resulting from the failure of the Contractor to maintain all the areas of work in a suitable dry condition, shall be repaired by the Contractor, as directed by the Engineer, at no additional expense to the Owner. The Contractor's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.

C. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water from the trenches, excavations, and stormwater management operations shall be disposed of in such a manner as to avoid public nuisance, injury to public health or the environment, damage to public or private property, or damage to the work completed or in progress.

D. The Contractor shall control the grading in the areas surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavated area. Where required, temporary ditches shall be provided to control drainage. Upon completion of the work and when directed, all areas shall be restored by the Contractor in a satisfactory manner and as directed.

1.11 BLASTING

A. Blasting shall not be permitted without the written approval of the Owner’s Representative.

1.12 PERMITS, CODES, AND SAFETY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of the municipality, the Commonwealth of Massachusetts, and other authorities having jurisdiction over the project site or work. All labor, materials, equipment and services necessary to make the work comply with these requirements shall be provided by the Contractor without additional cost to the Owner.

B. Comply with the provisions of the Manual for Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration, United States Department of Labor.

C. The Contractor shall obtain and pay for all permits and licenses required to the complete work specified herein and shown on the Contract Drawings.

D. The Contractor shall not close or obstruct any street, sidewalk, or passageway without written permission from authorities having jurisdiction unless otherwise indicated on the Contract Drawings. The Contractor shall conduct his operations as to minimize interference with the use of roads, driveways, or other facilities near enough to the work to be affected by the work.

E. The Contractor shall notify “Dig Safe” at 1-888-DIG-SAFE prior to commencing any excavation work.

F. The Contractor shall provide police details when working in roadways as required by local jurisdictional authorities. The Contractor shall pay for any and all details.

1.13 PROTECTION OF EXISTING CONDITIONS

A. All work shall be executed in such a manner as to prevent any damage to existing buildings, streets, curbs, paving, service utility lines, structures and adjoining property.

B. Locate and mark underground utilities to remain in service before beginning the work. Protect all existing utilities to remain in service during operations. Do not interrupt existing utilities except when authorized in writing by authorities have jurisdiction unless otherwise indicated on the Contract Drawings.

C. When an active utility line is exposed during construction its location and elevation shall be recorded on the Record Drawings by the Contractor and both the Engineer and the Utility Owner shall be notified in writing. Active utilities existing on the site shall be carefully protected from damage or relocated as required by the work.

D. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged, capped or filled. The location of such utilities shall be recorded on the Record Drawings.

E. Provide barricades, fences, lights, signs, and all other safety devices required to protect the public against injury.

F. In case of any damage or injury caused in the performance of the work the Contractor shall, at his own expense make good such damage or injury to the satisfaction of, and without cost to, the Owner. Existing streets, sidewalks and curbs damaged during the project work shall be repaired or replaced to their condition prior to commencement of Earth Moving operations.

G. Acceptance of any of the Contractor's plans, design calculations and methods of construction by the Designer shall not relieve the Contractor of the responsibility for the adequacy of the excavation lateral support system; preventing damage to existing or new structures, utilities and streets adjacent to excavations; the safety of persons working within excavated areas and the public at large; and excavation dewatering.

1.14 DISPOSAL

A. All excess and unsuitable excavated soil shall be removed from the site and legally disposed off-site by the Contractor at no additional cost to the Owner.

PART 2 – PRODUCTS

2.01 BACKFILL MATERIALS

A. Backfill materials shall conform to the following material descriptions and gradation requirements.

B. Ordinary Borrow: Ordinary borrow shall be well-graded, natural inorganic soil containing no stone greater than 6 inches maximum dimension. The materials shall be free of trash, ice, snow, tree stumps, roots and other organic and deleterious materials. It shall be free of highly plastic clays, of all materials subject to decay or other materials that will corrode piping or metals. Ordinary borrow shall have a maximum dry density of not less than 110 pounds per cubic foot. It shall be of such a nature and character that it can be compacted to the specified densities. Topsoil shall not be considered ordinary borrow.

C. Existing available fill materials from on-site excavations may be reused as ordinary borrow if it meets the above requirements.

D. Gravel Borrow: Gravel borrow shall consist of inert material that is hard, durable stone and coarse sand, free from loam and clay, surface coatings, and deleterious materials. Gravel borrow shall conform to the following gradation requirements:

Sieve Size	Percent Finer by Weight
1/2-inch	50-85(1)
No. 4	40-75
No. 50	8-28
No. 200	0-10
(1) Maximum size of stone in gravel shall be three-inches.	

E. Crushed Stone: Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements.

Percent Passing by Weight		
Sieve Size	**3/4-inch Stone**	**1/2-inch Stone**
1-inch	100	---
3/4-inch	90-100	---
5/8-inch	---	100
1/2-inch	10-50	85-100
3/8-inch	0-20	15-45
No. 4	0-5	0-15
No. 8	---	0-5

F. Dense Graded Crushed Stone: Dense graded crushed stone shall consist of angular material derived from a stone quarry that is hard, durable and free of deleterious materials. Material shall be free from clay, loam or other plastic material.

Sieve Size	Percent Passing By Weight
2-inch	100
1½-inch	70-100
¾ -inch	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

G. Sand: Sand shall consist of clean inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics, surface coatings or other deleterious material. Sand shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85-100
No. 4	60-100
No. 16	35-80
No. 50	10-55
No. 100	2-10

H. Dumped Riprap: Stone used for dumped riprap shall be hard, durable, angular in shape stones, resistant to weathering and shall meet the gradation requirement specified. Neither breadth nor thickness of a single stone should be less than one-third its length. Rounded stone or boulders will not be accepted unless authorized by the Engineer. Stone shall be free from overburden, spoil, shale, and organic material and shall conform to the following gradation:

Weight of Stone (lbs.)	Maximum Percent of Total Weight Smaller than Given Weight
400	100
300	50
200	30
25*	10
No more than 5% by weight shall pass a	

Weight of Stone (lbs.)	Maximum Percent of Total Weight Smaller than Given Weight
2-inch sieve	

Each load of riprap shall be reasonably well graded from the smallest to the maximum size specified.

I. Stone for Pipe Ends: Stone for pipe ends shall be sound, durable rock which is angular in shape. Rounded stones, boulders, sandstone or similar stone or relatively thin slabs will not be acceptable. Each stone shall weigh not less than 50 pounds but not more than 125 pounds and at least 75 percent of the volume shall consist of stones weighing not less that 75 pounds each. The remainder of the stones shall be graded that when placed with the larger stones the entire mass will be compact.

J. Filter Fabric: Filter Fabric used, as a drainage medium shall consist of a non-woven fabric made from polypropylene or polyethylene filaments or yarns. The fabric shall be inert to organic chemicals commonly encountered in the soil. The fabric shall conform to the following recommended property tests:

Property	Unit	Test Method	Minimum Value
Weight	oz/sy	ASTM D-3776-84	4.5
Grab Strength	lbs	ASTM D-4632-86	120
Grab Elongation	percent	ASTM D-4632-86	55
Trapezoid Tear Strength	lbs	ASTM D-4533-85	50
Mullen Burst Strength	psi	ASTM D-3786-80	210
Puncture Strength	lbs	ASTM D-4833-88	70
Apparent Opening Size (AOS)	U.S. std. Size Sieve	ASTM D-4751-87	70

K. Edges of filter fabric shall overlap a minimum of one foot.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contract Drawings indicate the proposed finish alignment, elevation, and grade of the work. Establish the line and grade in close conformity with the Contract Drawings. The Owner's Representative, however, may make minor adjustments in the field as necessary due to conditions encountered.

B. The Contractor is responsible for establishing construction phasing, means, and methods and interim grading and temporary conditions required to attain the finish product required by the Contract Documents. The Contractor is responsible for all construction, protection, movement, and maintenance of stockpiles. Establish and maintain suitable benchmarks and grade control to accurately perform the work.

C. All excavation shall be performed in the dry. Excavation and dewatering shall be accomplished by methods, which preserve the undisturbed state of the subgrade soils.

D. No excavation will be permitted below a line drawn downwards at 2 horizontal to 1 vertical from the underside of the closest edge of any in-place footing or utility at a higher elevation without providing adequate sheeting and bracing to prevent movement of the in-place footing or utility.

E. When excavations have reached the prescribed depths, the condition of the bottom of the trench or hole shall be inspected by the Owner's Representative. After inspection the Contractor will receive approval to proceed if conditions meet project requirements.

F. No excavation shall be deposited or stockpiled at any time to endanger portions of new or existing structures, either by direct pressure or indirectly by overloading banks contiguous to the operation. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction. If there is not sufficient area available for stockpiling within the limits of the project, the Contractor will be required to furnish his own area for stockpiling.

G. When the plans require excavation in areas in close proximity to existing buildings, roads, structures and utilities it shall be the responsibility of the Contractor at his expense to use satisfactory means and methods to protect and maintain the stability of such roads, and structures located immediately adjacent to but outside the limits of excavations.

H. Temporary ditches shall be made as needed to drain off surface water to avoid damaged to areas of cut or fill. Such ditches shall be maintained as required for efficient operations, at no additional cost to the Owner.

I. Provide shoring, sheeting, and/or bracing at excavations, as required, to assure complete safety against collapse of earth at the side of excavations. Provide shoring of public utility lines where exposed in the excavations in accordance with rules and regulations of the local authorities, as no additional cost to the Owner.

3.02 FILLING AND BACKFILLING

A. Subgrade Preparation: The subgrade shall be shaped to line, grade, and cross-section, and be thoroughly compacted in accordance with the requirements of paragraph 3.03. This operation shall include any required reshaping and wetting to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material from excavation or borrow. The resulting area, and all other low sections, holes, or depressions shall be brought to the required grade with accepted material and the entire subgrade shaped to line, grade and cross-section and thoroughly compacted.

1. Before surface or base materials are spread, the subgrade shall be shaped to an accurate and true surface conforming to the line and grades indicated on the Contract Drawings. All surface irregularities shall be filled with suitable material or removed and such areas recompacted until the surface is properly shaped and properly compacted. A tolerance of 3/8-inch in paved areas and 1/2-inch in non-paved areas above or below the finished subgrade elevation will be allowed provided that this dimension above or below grade is not maintained for a distance longer than 50-feet and that the required crown is maintained in the subgrade. Any portion, which is not accessible to a roller, shall be thoroughly compacted by other mechanical or manual methods.

2. All fills shall be placed in horizontal layers. Fill shall not be placed following the natural contours of the ground. Fill shall be placed starting in the lowest areas working up to finish grades in horizontal layers in the manner specified herein. Each layer of fill shall be benched into the existing slope in order to avoid the formation of a shear plane.

B. Backfill Material: Unless otherwise specified or directed, material used for filling and backfilling shall meet the material requirements specified herein. In general, the material used for backfilling utility trench excavations shall be material removed from the excavations provided that the reuse of these materials result in the required trench compaction and meets the requirements specified for ordinary borrow. All backfill placed within the building limits shall be gravel borrow unless otherwise specified. In areas where the bottom of the excavation is in fine sand and silt, and is below the groundwater table, the first lift of backfill shall be 12-inches of compacted sand and gravel to provide a working mat and drainage layer. Place backfill to a maximum loose lift thickness of 12-inches. Maintain backfill material with a uniform moisture content, with no visible wet or dry streaking, between plus two percent and minus three percent of optimum moisture content. The final filled soil mass shall be as uniform as possible in lift thickness, moisture content, and effort required to compact soil mass.

C. Trench Backfill:

1. After the utility pipe installation has been inspected and approved, trenches shall be backfilled as soon as practicable with specified material. All trench backfilling shall be done with special care.

2. Backfill material for pipe bedding shall be deposited in the trench, uniformly on both sides of the pipe, for the entire width of the trench to the springline of the pipe. The backfill material shall be placed by hand shovels, in layers not more than 8-inches thick in loose depth, and each layer shall be thoroughly and evenly compacted by tamping on each side of the pipe to provide uniform support around the pipe, free from voids.

3. The balance of backfill shall be spread in layers not exceeding 12-inches in loose depth. Each layer shall be thoroughly compacted by mechanical methods and shall contain no rock, stones or boulders larger than 4 inches in their greatest dimension.

4. All trench backfilling shall be done with special care and must be carefully placed so as not to disturb the work at any time; if necessary, a timber grillage or other suitable method shall be used to break the fall of the material. The moisture content of the backfill material shall be such that proper compaction will be obtained. Puddling of backfill with water will not be permitted. Backfill within areas to receive topsoil or pavement construction shall be made to grades required to establish the proper subgrade for the placement of topsoil or pavement base courses.

5. In backfilling trenches, each layer of backfill material shall be moistened and compacted to a density at least equal to that of the surrounding undisturbed earth, and in such a manner as to permit the rolling and compaction of the filled trench or excavation with the adjoining earth to provide the required bearing value, so that paving of the excavated and disturbed areas, where required, can proceed immediately after backfilling is completed.

6. Any trenches or excavations improperly backfilled or where settlement occurs shall be reopened, to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional expense to the Owner.

7. During filling and backfilling operations, pipelines will be checked by the Owner's Representative to determine whether any displacement of the pipe has occurred. If the observation of the pipelines shows poor alignment, displaced pipe or any other defects they shall be remedied in a manner satisfactory to the Owner's Representative at no additional cost to the Owner.

D. Backfilling Against Structures:

1. Backfilling against masonry or concrete shall not be done until permitted by the Owner's Representative. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed and approved, special leakage tests of the structures shall be made by the Contractor, as required by the Owner's Representative. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using suitable and approved excavation material. The best of the backfill material shall be used for backfilling within 2-feet of the structure. Just prior to placing backfill, the areas shall be cleaned of all excess construction material and debris and the bottom of excavations shall be in a thoroughly compacted condition.

2. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures. During backfilling operations, care shall be exercised that the equipment used will not overload the structures in passing over and compacting these fills. Except as otherwise specified or directed, backfill shall be placed in layers not more than 12-inches in loose depth and each layer of backfill shall be compacted thoroughly and evenly using approved types of mechanical equipment. Each pass of the equipment shall cover the entire area of each layer of backfill.

3. In compacting and other operations, the Contractor shall conduct his operations in a manner to prevent damage to structures due to passage of heavy equipment over, or adjacent to, structures, and any damage thereto shall be made good by the Contractor at no additional expense to the Owner.

E. After backfilling trenches and excavations, the Contractor shall maintain the surfaces of backfill areas in good condition so as to present a smooth surface at all times level with adjacent surfaces. Any subsequent settling over backfilled areas shall be repaired by the Contractor immediately, and such maintenance shall be provided by the Contractor for the life of this Contract, at no additional expense to the Owner.

F. The completed and approved subgrades upon which topsoil is to be placed, or pavements are to be installed, shall not be disturbed by traffic of other operations and shall be maintained in a satisfactory condition until the base and finished courses are placed. The storage or stockpiling of materials on finished subgrade will not be permitted.

G. Uniformly shape the surfaces of all areas to be graded, to the lines and grades indicated on the Contract Drawings, and as directed, including excavated and filled sections, embankments and adjacent transition areas, and all areas disturbed as a result of the Contractor's operations. The finished surfaces shall be reasonably smooth, compacted and free from surface irregularities.

H. The Contractor is responsible to provide the finish grades as shown on the Contract Drawings. The Contractor shall provide temporary erosion control throughout the construction period to maintain all constructed lawns, and to protect all existing drains, catch basins, swales, from any debris or soil entering from excavation, backfill, or erosion. Contractor shall take whatever precautions are necessary to accomplish this temporary erosion control such as haybales, silt fence, erosion control fabric, or pumping, at no additional cost to the Owner.

3.03 COMPACTION

A. Compaction Requirements: The degree of compaction is expressed as a percentage of the maximum dry density of the material at optimum moisture content as determined by ASTM Test D1557, Method C. The compaction requirements are as follows:

Area	ASTM Density Degree of Compaction
Below footings	95%
Below slabs	95%
Pavement base course	95%
Pavement subgrade	95%
General fill below pavement subbase	95%
Trench backfill - below pavements - below landscaped areas - below structures	95% 92% 95%
All other areas	90%

B. Moisture Control:

1. Fill that is too wet for proper compaction shall be disced, harrowed, or otherwise dried to a proper moisture content to allow compaction to the required density. If fill cannot be dried within 24 hours of placement, it shall be removed and replaced with drier fill.

2. Fill that is too dry for proper compaction shall receive water uniformly applied over the surface of the loose layer. Sufficient water shall be added to allow compaction to the required density.

C. Unfavorable Conditions:

1. In no case shall fill be placed over material that is frozen. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.

2. In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of the day's operations. Prior to terminating work for the day, the final layer of compacted fill shall be rolled with a smooth wheeled roller to eliminate ridges of soil left by compaction equipment.

D. Compaction Control:

1. In-place density tests shall be made in accordance with ASTM D1556, D2922, or D2167 as the work progresses, to determine the degree of compaction being attained by the Contractor. Any corrective work required as a result of such tests, such as additional compaction, or a decrease in the thickness of layers, shall be performed by the Contractor at no additional expense to the Owner. In-place density testing shall be made at the Contractor's expense by the geotechnical testing laboratory.

2. In-place density tests shall be performed at a minimum according to the following:

   a. A minimum of one per trench.

b. One test per lift for each parking lot and sidewalk subgrade area.

E. Erosion control

1. The work of the Section consists of all sedimentation and erosion control related items as indicated on the Contract Drawings and/or specified herein and includes but is not limited to the following:

   a. Silt fence.
   b. Hay bale barriers.
   c. Temporary covers for drainage structures.
   d. Temporary protective soil coverings.

2. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor and Sub-contractor's construction methods and operations, the weather conditions, and as directed by the Engineer.

END OF SECTION 312000

SECTION 31 2219

FINISH GRADING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Execute finish grades complete, as shown on the Drawings, and as specified herein.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Electrical – Section 26 0001
2 Earthwork - Section 31 2000
3 Site Concrete - Section 32 1313
4 Unit Paving – Section 32 1400
5 Miscellaneous Site Improvements - Section 32 3000
6 Fencing - Section 32 3100
7 Planting - Section 32 9000
8 Soil Preparation - Section 32 9113

1.04 PROJECT/SITE CONDITIONS

A Dust Nuisance: Assume full responsibility for alleviation or prevention of dust as a result of grading work.

1.05 SEQUENCING AND SCHEDULING

A Regrade as required to finish grades and to the satisfaction of the Landscape Architect.

1.06 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architects designated representative.

PART 2 – PRODUCTS

2.01 EQUIPMENT: At Contractor's option.

PART 3 – EXECUTION

3.01 EXAMINATION

A Verification of Conditions: Verify that the following items have been completed prior to commencement of finish grading:

1 Installation of the topsoil and all soil preparation including debris removal.

2 Incorporation of soil amendments (as required by the Soil Testing Laboratory Report) and as otherwise specified.

3.02 INSTALLATION

A Paved Area Finish Grading

1 Provide finish grading as shown on the Drawings and as specified.

2 All walks must be a maximum of 5%. Any discrepancies shall be brought to the attention of the landscape Architect before the installation of the paving.

3 Cross-slopes including but not limited to walkways, plazas, sidewalks, play surfaces, pedestrian paving, vehicular drop off area and handicap parking areas shall be graded at a maximum of 2 % cross slope. Any discrepancies shall be brought to the attention of the landscape Architect before the installation of the paving.

B Miscellaneous items and materials such as but not limited to area drains, site lighting, walks, walls, curbs, tree grate frames, fencing and gates, and trash receptacles shall relate to the adjacent finish grade surfaces as shown on the drawings and as specified.

C Finish Landscape Grading

1 Provide all grading as shown on the Drawings and as specified.

2 Provide all grades for natural runoff of water without low spots or pockets. Accurately set flow line grades at 2 %minimum gradient unless otherwise noted in Drawings.

3 Finish grade all mulch areas, plant beds, lawn and sod areas by hand raking. Finish grades shall be smooth, even and on a uniform plane with no abrupt changes of surface. Slope uniformly between given spot elevations, unless otherwise shown on drawings.

4 Grades not otherwise indicated shall be uniform levels or slopes between points where elevations are given, or between points established by walks, paving, curbs or catch basins.

5 Tops and toes of all slopes shall be rounded to produce a gradual and natural appearing transition between relatively level areas and slopes.

D Tolerances:

1 As noted in 3.02, A, 2 and 3 of this section.

2 All planting areas, including lawn areas, shall be true to grade within 1 in. when tested with a 5 ft. straightedge.

3 Hold finished grades of Amended topsoil and backfill mixes below top of adjacent pavement, headers, curbs, or walls as follows:

a Trees, Shrub, Annual, Perennial and Groundcover Areas: (1) inch.

b Seeded Lawn Areas: Flush.

c Sodded Lawn: (1) inch.

END OF SECTION

SECTION 312500

SEDIMENTATION AND EROSION CONTROL

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. The work of the Section consists of all sedimentation and erosion control, and related items as indicated on the Contract Drawings and/or specified herein and includes but is not limited to the following:

a. Silt fence.
b. Hay bale barriers.
c. Temporary covers for drainage structures.
d. Temporary protective soil coverings.

2. The Contract Drawings indicate the minimum requirements for sedimentation control. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor and Sub-contractor's construction methods and operations, the weather conditions, and as directed by the Engineer.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 312000 – EARTH MOVING for excavation, backfill and compaction requirements.
2. Section 334000 – STORM DRAINAGE UTILITIES for drainage systems requirements.

1.3 SUBMITTALS

A. Refer to SECTION 013000-SUBMITTALS for submittal provisions and procedures.

1. At least 20 days prior to the start of the project, the Contractor shall submit a Storm Water Pollution Prevention Plan (SWPPP) indicating project phasing, Contractor operation areas, work areas, stockpile locations, construction staging/sequencing, and sedimentation/erosion control measures to be used. The SWPPP shall be prepared to meet the requirements of the United States Environmental Protection's (EPA) National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges From Construction Activities (GCP). The Contractor shall also submit the EPA "Notice of Intent for Storm Water Discharges Associated with CONSTRUCTION ACTIVITY Under a NPDES General Permit." (NOI) form. This form shall be submitted to the EPA at least 14 days prior to the start of any construction activity and placing a signed copy along with proof of mailing in the SWPPP.
2. As part of the Contract Closeout procedures, the Contractor is responsible for filing a Notice of Termination with the EPA once the project has been completed and is permanently

stabilized. Stabilization is complete when all temporary storm water and erosion controls have been removed, all permanent storm water and erosion controls are in place and functional and all vegetated areas are at least 70% viable.

3. The Contractor shall provide the following samples and/or submittals for approval. Do not order materials until approval of samples, certifications or test results has been obtained. Delivered materials shall closely match the approved samples.

    a. Siltation Fence: Submit manufacturer's literature, material specification, and installation instructions.
    b. Mulch Material: Submit one cubic foot sample(s).
    c. Mesh or Blanket Matting: submit one square foot sample(s) and manufacturer's literature, material specification, and installation instructions.

4. The Contractor shall install and maintain sedimentation control devices during construction to prevent the movement of sediment from the construction site to off site areas, into adjacent water bodies via surface runoff or into underground drainage systems. Measures to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.

1.4 QUALITY ASSURANCE

A. Comply with all applicable requirements of governing authorities having jurisdiction. The specifications and drawings are not represented as being comprehensive, but rather convey the intent to provide complete slope protection and erosion control for both the Owner’s and adjacent property.

    1. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to a sediment and erosion control plan specific to the site, which complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

B. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to severe erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.

C. The Contractor shall install and maintain sedimentation control devices during construction to prevent the movement of sediment from the construction site to off site areas, into adjacent water bodies via surface runoff or into underground drainage systems. Measures to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.

D. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.

E. Surface water runoff originating upgrade of exposed areas shall be controlled to reduce erosion and sediment loss during the period of exposure.

F. When the increase in the peak rates and velocity of storm water runoff resulting from a land-disturbing activity is sufficient to cause accelerated erosion of the receiving stream bed, provide measures to control both the velocity and rate of release so as to minimize accelerated erosion and increased sedimentation of the stream.

G. All land-disturbing activities are to be planned and conducted so as to minimize off-site sedimentation damage.

H. The Contractor is responsible for cleaning out and disposing of all sediment once the storage capacity of the sediment facility is reduced by one-half.

I. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

1.5 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. "Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas, A Guide for Planners, Designers and Municipal Officials", prepared by the Massachusetts Department of Environmental Protection, Bureau of Resource Protection, dated March 1997, reprinted May 2003.

1.6 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.7 PERMITS, CODES AND REGULATIONS

A. Comply with all rules, regulations, laws and ordinances of the City and State, and all other authorities having jurisdiction over the project site. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided by the Contractor without additional cost to the Owner.

B. Comply with all applicable regulations of the Commonwealth of Massachusetts Department of Environmental Protection (DEP) and the EPA.

C. The Contractor shall comply with the requirements of the NPDES GCP for this project.

PART 2 - PRODUCTS

2.1 SILTATION FENCE

A. Siltation fence shall consist of the following elements:

1. Fabric for siltation fence shall be a minimum width of 3 feet and conforming to the following criteria:

MINIMUM ACCEPTABLE

Fabric Properties	Value	Test Method
Grab Tensile Strength (lbs)	124	ASTM D 4632
Elongation of Failure (%)	15	ASTM D 4632
Mullen Burst Strength (PSI)	300	ASTM D 3786
Puncture Strength (1bs)	65	ASTM D 4833
Flow Rate (gal/min/sf)	10	ASTM D 4491
Apparent Opening Size (sieve)	30	ASTM D 4751
Ultraviolet Radiation (% strength retained)	70	ASTM D 4355

2. Use only commercially available fabric that is certified in writing by the manufacturer for the purpose intended.
3. Acceptable fabric materials include "Mirafi Envirofence" by TC Mirafi, "Style 2130" by Amoco Fabrics Co., and "FX-55" by Carthage Mills, or approved equal by the Engineer.
4. Silt fence posts: Posts may be wood or metal. Wood post shall be a minimum 1¼ inch by 1¼ inch by 5 feet long hardwood stakes commonly used to support siltation fabric. Metal posts shall be a minimum of 1 inch wide and 5 feet long. Posts shall be spaced at a maximum distance of 8 feet on center.
5. Provide suitable heavy nylon cord for securing abutting silt fence posts.

2.2 CRUSHED STONE

A. Crushed stone shall be as specified in Section 312000, Earth Moving.

2.3 STRAW BALES

A. Straw bales shall be of wire or nylon bound bales of straw.

B. Stakes for bales shall be one of the following materials. Lengths shall be approximately three feet (3').

1. Wood stakes of sound hardwood, one inch by one inch (1" x 1") in size.
2. Steel reinforcing bars of at least No. 4 size.

2.4 TEMPORARY COVERS FOR DRAINAGE STRUCTURES

A. Filter fabric for use as temporary covers for drainage structures shall be the same as noted above for siltation fence.

B. Wire mesh for use at temporary drainage structure covers shall be 6" x 6", W2.9 welded wire mesh.

C. Crushed stone shall be as specified herein before.

D. Silt-Sac, Hydro-FloGard + Plus Catch basin Insert, Ultra-DrainGuard Insert, or approved equal, may be used in lieu of hay bales and filter fabric at catch basins.

2.5 TEMPORARY PROTECTIVE COVERINGS

A. During establishment of vegetative covers, provide temporary protective coverings on ground areas subject to erosion of one of the following protective measures, as directed by the Engineer:

1. Hay or straw temporary mulch, 100 pounds per 1,000 square feet.
2. Wood fiber cellulose temporary mulch, 35 pounds per 1,000 square feet.

3. Tackafier for anchoring mulch or straw shall be a non-petroleum based liquid bonding agent specifically made for anchoring hay or straw.
4. Temporary vegetative cover for graded areas shall be undamaged, air dry threshed straw or hay free of undesirable weed seed.
5. Mesh or Blanket Matting: Matting for erosion control on seeded or hydroseeded slopes, on planted surfaces, drainage swales, and on temporary or permanent slopes shall be:

    a. Biodegradable straw, excelsior wood, or coconut fiber and photodegradable netting sewn together with cotton thread.
    b. A flexible three-dimensional web of bonded polypropylene or PVC monofiliments.
    c. Heavy jute mesh shall be of a uniform open plain weave of unbleached singe jute yarn.
    d. Use only commercially available blanket mattings that are designed specifically for the intended use and certified in writing by the manufacturer for the purpose intended.
    e. Erosion control matting shall be "Soil Saver" manufactured by Jim Walls Co., Dallas, TX; "Heavy Duty Jute Mesh" manufactured by Lewis International Corp., Springfield, NJ or approved equal.

Note that wire staples and non-biodegradable coverings shall not be used for any area that will be mown turf.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Contractor shall provide suitable and adequate means of sedimentation and erosion control during construction. Control measures shall prevent all erosion, siltation and sedimentation of waterways, drainage systems, construction areas, adjacent areas and off-site areas. Work shall be accomplished on and/or adjacent to the following work areas:

1. Earthwork stockpiles and on-site storage and staging areas.
2. Cut and fill slopes and other stripped and exposed graded areas.
3. Constructed and existing swales and ditches.
4. Unestablished lawns and seeded embankments.

B. Means of protection as noted on the Contract Drawings indicate the minimum provisions necessary. Additional means of protection shall be provided by the Contractor as required for continued or unforeseen erosion problems, at no additional expense to the Owner.

C. Periodic maintenance of all sediment control installations shall be provided to ensure intended purposes are accomplished. Sediment control measures shall be in working condition at the end of each day.

D. After any significant rainfall, sediment control devices shall be inspected for integrity. Any damaged device shall be corrected immediately.

E. The Contractor shall provide adequate means of control of runoff, as to not detrimentally impact downstream conditions during construction. The Contractor shall plan his operations so that permanent drainage mitigation systems such as detention/retention/infiltration basins and chambers are in place and properly functioning prior to connecting upland drainage flows to these systems. The Contractor shall plan his operations such that downstream drainage mitigation measures are in place and functioning before attempting to tie in upgradient drainage systems.

F. In the event that the Contractor is unable to sequence the work so that construction of the permanent drainage mitigation systems precedes the upland work, then the Contractor shall submit a plan indicating his proposed methods of otherwise controlling runoff from the site.

G. The "Massachusetts Erosion and Sedimentation Control Guidelines for Urban and Suburban Areas" should be consulted as a guide for the selection and installation of Best Management Practices to suit the conditions encountered.

3.2 SILTATION FENCE

A. Install silt fence, well-staked at maximum eight-foot intervals in locations as shown on Contract Drawings and as directed. Staking shall occur on the disturbed area side.

B. Secure fabric to posts on upstream side and bury fabric end within a 6-inch wide by 6-inch deep cut-in trench. Wrap the fabric bottom around the inside of the trench and backfill excavated soil into the fabric pocket to anchor the fence fabric.

C. Inspect siltation fence after major storm events and periodically and remove accumulated sediment and debris. If a breach or failure of the siltation fence occurs, the fence shall immediately be restored.

3.3 STRAW BALE BARRIERS

A. Install Straw bales in location as shown on Contract Drawings and as directed.

1. Bales shall be placed in a row with ends tightly abutting the adjacent bales.
2. Each bale shall be embedded in the soil a minimum of four inches (4").
3. Bales shall be securely anchored in place by stakes or re-bars driven through the bales and a minimum eighteen inches (18") into the soil. The first stake in each bale shall be angled toward the previously laid bale to force bales together.

B. Inspection shall be frequent and repair or replacement shall be made as needed.

C. Bales shall be removed when they have served their usefulness so as not to block or impede stormwater flows or drainage.

3.4 STABILIZED CONSTRUCTION ENTRANCE AND STONE BERMS

A. Stone size: Use ASTM designation C-33, size No. 2 (1-1/2” to 2-1/2”). Use crushed stone.

B. Length: As effective, but not less than 50 feet.

C. Thickness: Not less than eight inches.

D. Width: Not less than full width of all points on ingress or egress, but not less than 25 feet.

E. Washing: When necessary, wheels shall be cleaned to remove sediment prior to entrance onto public right-of-way. When washing is required, it shall be done on an area stabilized with crushed stone which drains into an approved sediment trap or sediment basin. All sediment shall be prevented from entering any storm drain, ditch, or watercourse through the use of sand bags, gravel boards or other approved methods.

F. Maintenance: The entrance shall be maintained in a condition which will prevent tracking or flowing of sediment onto public rights-or-way. This may require periodic top dressing with additional stone

as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spoiled, dropped, washed or tracked onto public rights-of-way must be removed immediately.

G. Place crushed stone berms in locations required and as directed. Berms shall have side slopes of 1:3 or less.

H. Inspect stone berms periodically and replace and/or regrade crushed stone as required.

3.5 TEMPORARY COVERS FOR DRAINAGE STRUCTURES

A. Install temporary covers at drainage structure locations that may be subject to erosion infiltration and as directed by the Engineer.

B. Inspect drainage structures periodically. Remove sediment accumulation and regrade or replace materials as required.

3.6 TEMPORARY PROTECTIVE COVERINGS

A. Place temporary soil coverings to control erosion and sedimentation on all disturbed or graded areas as required by the construction methods employed and as directed by the Engineer. Erosion control matting shall be installed in all areas seeded or hydroseeded with slopes of one vertical foot to three foot horizontal, or steeper, immediately after such areas have been seeded and a hay mulch applied as follows:

1. The area to receive matting shall have been recently seeded and shall have a smooth surface free front stones, clods or depressions.
2. Roll out of the matting perpendicular to the slope, do not stretch the fabric. In drainage swales, center the fabric along the flow line. Install the matting in a check slot at the top and bottom of the slope and at the edges of the area to be covered. Check slots shall be six inches deep and six inches wide. Fabric shall extend down one wall of the check slot and across the full width of the base. Overlap edges of matting rolls four (4) inches minimum and overlap the ends eighteen (18) inches minimum.
3. Install staples in check slots, edges, center and ends of rolls by driving specified steel staples two feet on center over the entire area to be covered except at check slots and ends of rolls, where staples shall be placed six inches on center. All staples shall be driven below finished grade.
4. Fill check slots with loam and tamp firmly.
5. Reseed check slots and all disturbed areas per Specifications.
6. Following matting installation, roll the entire area with a smooth drum roller weighing between fifty and seventy-five (50-75) pounds per linear foot of roller. The finished installation of matting shall be firmly in contact with the seeded area and provide a smooth, finished appearance free from lumps or depressions.

B. Install erosion control matting as a temporary ground cover in all disturbed or graded areas subject to erosion and as directed by the Engineer. The temporary ground cover shall protect the site from erosion until a full permanent lawn can be installed. Install and anchor in place temporary erosion control matting in accordance with manufacturer's printed instructions or as directed by the Engineer and remove all temporary erosion control matting prior to installation of a permanent lawn.

C. Inspect protective coverings periodically and reset or replace materials as required.

3.7 EROSION CONTROL GRASSING

A. Grassing shall be applied according to State of Massachusetts Highway Department Standard Specifications.

3.8 DUST CONTROL

A. Throughout the construction period the Contractor shall carry on an active program for the control of fugitive dust within all site construction zones, or areas disturbed as a result of construction. Control methods shall include the following: Apply calcium chloride at a uniform rate of one and one-half (1 ½) pounds per square yard in areas subject to blowing. For emergency control of dust apply water to affected areas. The source of supply and the method of application for water are the responsibility of the contractor.

B. The frequency and methods of application for fugitive dust control shall be as directed by the Architect with concurrence by the Owner's representative.

3.9 TEMPORARY PROTECTIVE COVERINGS (AFTER GROWING SEASON)

A. Place temporary covering for erosion and sedimentation control on all areas that have been graded and left exposed after October 30. Contractor shall have the choice to use either or both of the methods described herein.

B. Hay or straw shall be anchored in-place by one of the following methods and as approved by the Architect with concurrence by the Owner's representative: Mechanical "crimping" with a tractor drawn device specifically devised to cut mulch into top two inches of soil surface or application of non-petroleum based liquid tackifier, applied at a rate and in accordance with manufacturer's instructions for specific mulch material utilized.

C. Placement of mesh or blanket matting and anchoring in place shall be in accordance with manufacturer's printed instructions.

D. Inspect protective coverings periodically and reset or replace materials as required.

3.10 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion, and with the approval of the Owner's Representative remove sediment control devices and all accumulated silt. Dispose of silt and waste materials offsite. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated.

END OF SECTION 312500

SECTION 321000

BASES, BALLASTS, AND PAVING

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Bituminous Concrete Pavements.

2. Cement Concrete Sidewalks.

3. Crack Sealing.

4. Cold-planing of pavements.

5. Setting of Curb.

6. Installing Pavement Markings.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 312000, Earth Moving.

2. Section 344113, Traffic Signals.

3. Section 033000, Cast-In-Place Concrete.

1.3 SUBMITTALS

A. Refer to Section 013300 - Submittals for submittal provisions and procedures.

1. Material Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

2. Submit shop drawings for curbing items.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. Commonwealth of Massachusetts, Massachusetts Highway Department (MHD), Standard Specifications for Highways and Bridges, latest English Edition with amendments, hereinafter

referred to as the “Standard Specifications.” All references to method of measurement, basis of payment and payment items in the Standard Specifications are hereby deleted. References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned therein.

2. ASTM: American Society for Testing and Materials.

3. AASHTO: American Association of State Highway and Transportation Officials.

4. ACI: American Concrete Institute.

5. MUTCD: Manual on Uniform Traffic Control Devices.

1.5 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 WEATHER CONDITIONS

A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50° F (10° C), and when temperature has not been below 35° F (1° C) for 12 hours immediately prior to application. Do not apply when base surface is wet or contains an excess of moisture.

B. Spread asphalt concrete courses when atmospheric temperature is above 40° F (4° C), and when base surface is dry. Base course may be placed when air temperature is above 30° F (-1° C) and rising.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Subgrade base course material shall conform to the applicable subsections of Section 312000, Earth Moving of this Specification.

B. Bituminous Concrete Base Course shall conform to the applicable subsections of Section 420, Class I Bituminous Concrete Base Course, Type I-1 of the "Standard Specifications".

C. Bituminous Concrete Pavement shall conform to the applicable subsections of Section 460, Class I Bituminous Concrete Pavement, Type I-1 of the "Standard Specifications."

D. Cement Concrete Pavement shall achieve a 28 day minimum compressive strength of 4,000 psi, and conform to the applicable subsections of Section M4 of the “Standard Specifications”.

E. Lane Marking Paint: Fast Drying White Traffic Paint and Fast Drying Yellow Traffic Paint as specified in the "Standard Specifications" under Sections M7.01.10, and M7.01.11, respectively.

F. Detectable Warning Panels shall have done geometry in accordance with ADA Regulations for

Detectable Warning on Curb Ramps. They shall be raised truncated domes with a nominal diameter of 0.9-inches, a nominal height of 0.2-inches, and a center-to-center spacing of 1.6 inches to 2.4-inches. Panels shall be 24-inches deep in the direction of travel and the full width of the proposed ramp. The panel shall be a homogenous glass and carbon reinforced composite, which is colorfast, and UV stable. The panel is to be colored throughout and not a painted coating. The color is to be contrasting to the background sidewalk color. The panels shall have a compressive strength in excess of 10,000 psi, flexural strength in excess of 3,000 psi and a slip resistance in excess of 0.8 wet or dry.

2.2 RECLAIMED BASE COURSE

A. The work under this item shall consist of scarifying and pulverizing in place the existing asphalt pavement and underlying material, mixing and blending the material, and spreading and compacting the mixture to the lines and grades shown on the Contract Drawings.

B. Equipment such as rear-mounted ripper crushers and cold planing/milling equipment will not be permitted to perform the work under this item.

C. Prior to scarifying and pulverizing the pavement, the Contractor shall locate, protect, or remove all drainage and utility structure castings. All lowered structures shall be protected and covered by a steel plate and all watergates shall be covered as well to prevent any materials from falling into the bottom sections. All materials that fall into any structures as a result of the Contractor's operations shall be removed by the Contractor at no additional cost.

D. The existing full bituminous pavement structure and underlying base materials shall be simultaneously crushed, pulverized, and blended into a homogenous material to create the following gradation:

Sieve Designation	Percent Passing
2-inch	100
1½-inch	70-100
½-inch	50-85
No. 4	30-60
No. 50	8-28
No. 200	0-10

E. The construction operation shall be performed in such a manner as to allow for continuous vehicular access as required by the project schedule. Emergency vehicular access shall be maintained at all times.

2.3 BITUMINOUS CONCRETE CURB

A. Bituminous concrete curb shall conform to Section 501.64 of the Standard Specifications for Class 1 Bituminous Concrete Curb, Type-2 and Type-3 and shall meet the dimensions as shown on the Contract Drawings.

B. Bituminous concrete shall meet the requirements of Dense Mix as specified in the Standard Specifications under Section M3.12.00.

2.4 PRECAST CONCRETE CURB

A. Precast concrete curb units shall consist of castings conforming to a 6-inch by 18-inch nominal profile size with a 7-inch base dimension. Straight curb shall be cast in minimum lengths of 6 feet. Straight and curved curb may be cast in lengths of not less than 3 feet for closure sections only. Curb on a

radius of 100 feet or less shall be cast in radius forms to the correct radius. The Contractor shall supply special cast corner sections for all corners where curb runs change direction. All curbs shall have a ½-inch chamfered edge on both ends and front sides as detailed. The front top edge shall have a ¾-inch radius and the back top edge shall have a ¼-inch radius.

B. Curb shall be made of Portland cement types I or III, conforming to ASTM C150. Admixtures shall meet ASTM C233. Forms shall be made of metal to tight, rigid construction with true surfaces. Wood forms are not acceptable except for cast-in-place closure sections.

C. Concrete mix for curb shall be made of a maximum ¾-inch aggregate with a design strength of 5,000 psi at 28 days. An air-entraining agent shall be added at the mixer in accurately proportioned amounts to give air content to the concrete of not less than 5 percent and not more than 7 percent by volume. A high range water-reducing agent (super plasticizer) shall be added at the mixer in accurately proportioned amounts to meet design strength requirements and maintain a smooth, dense surface on the curb.

D. Surface Treatment: Upon removal from the forms, the surfaces of the curb shall have all surfaces rubbed with a carborundum stone to fully remove any rough or imperfections in the cast finish. All curbing sections shall have a uniform color and finish appearance and shall be approved by the Architect. An approved sample shall be standard for the entire job.

E. Curb shall be reinforced with bars conforming to ASTM A615.

2.5 GRANITE CURB AND EDGING

A. Granite curb and edging shall be light gray in color, free of seams and other imperfections, which would affect its structural integrity. The front face of the stone shall be at right angles to the plane of the top and the ends and shall have a smooth surface. The ends of the stones shall be square with the planes of the top and front face to provide flush joints. Top surface shall be sawn cut with a split front face.

B. Granite curb shall have a top width of six-inches and a depth of 17 to 19-inches and a minimum lengths of 6-feet. Granite edging shall have a thickness of five to six-inches and a depth of 11 to 13-inches with a minimum length of 4-feet.

C. Granite curb to be set on a radius of 100-feet or less shall be cut to the required radius. Granite edging set on a radius of 160-feet or less shall be supplied in lengths shorter than 6-feet but no less than 1-foot to provide a smooth appearance.

D. The ends of all transition curb shall be cut with a power driven saw to provide a flush vertical joint with adjacent curbing

2.6 EXPANSION JOINT FILLER AND SEALANT

A. Expansion joint filler strips shall conform to the requirements of AASHTO M-33.

B. Joint sealant shall be a self-leveling, gun-grade, non-staining, polyurethane-based material which cures at ambient temperature to a firm flexible tear resistant rubber made specifically for its intended use. The color shall be concrete gray.

2.7 STEEL REINFORCEMENT

A. Welded wire fabric reinforcement shall conform to the applicable standards of ASTM A185. Fabric Reinforcement shall be furnished in flat sheets. Fabric reinforcement in rolls will not be permitted.

PART 3 – EXECUTION

3.1 GENERAL

A. Subbase under paving shall be compacted as described in Section 312000, Earth Moving. Add material meeting the requirements of ordinary borrow to bring the subgrade to the required grade as necessary before placing base course.

B. The gravel base course shall be spread in layers upon the prepared subgrade conforming to the required line and grade. Gravel shall be placed in compacted layers not more than 4 inches thick compacted to not less than 95 percent of the maximum dry density of the material. Any stone greater than 3 inches in size shall be removed. Compaction shall continue until the surface is even and true to line and grade.

C. Gravel base course shall be placed on backfilled and compacted trenches to proper grade before placement of pavement.

D. The edges of existing pavement that is to remain shall be saw cut to an even, straight edge using a power-driver rotary saw; use of a jackhammer is unacceptable. This includes road, parking lot, sidewalk, and utility trench edges.

E. Bituminous concrete courses shall be spread and compacted to the finished thicknesses as shown on the Contract Drawings. A smooth even surface shall be produced.

F. Any joints at junctions of old and new pavements shall be sealed with a hot poured rubber asphalt sealer and covered with sand.

3.2 COLD-PLANING

A. This work consists of removing bituminous or cement concrete pavements by use of a cold planer in areas designed on the Contract Drawings. The cold planer must be equipped with an elevating device capable of loading planed material directly into dump trucks while operative. It shall have all the necessary safety devices, such as reflectors, headlights, taillights, flashing lights, and backup signals so as to operate safely in traffic both day and/or night.

B. The cold planer shall be designed and built for planing flexible pavements and possess the ability to plane cement concrete patches when encountered in bituminous pavement. It shall be self-propelled and have the means for planing without tearing or gouging the underlying surface. Variable lacing patterns shall be provided to permit a rough grooved or smooth surface as directed.

C. The cold planer shall be able to make up to a 3 inch cut or any specified lesser depth may be required in one pass. The minimum width of pavement planed in each pass shall be 6 feet, except in areas to be trimmed and edged. The machine shall be adjustable as to crown and depth and meet the standards set by the Air Quality Act for noise and air pollution.

D. The planed surface shall conform to the grade and cross-slope required. The surface shall not be torn, gouged, shoved, broken, or excessively grooved. It shall be free of imperfections in workmanship that prevent resurfacing after this operation. Surface texture shall be as specified by the Engineer and excess material shall be removed so the surface is acceptable to traffic if required.

3.3 CURBING AND EDGING

A. Construct curbing and edging of the type and at the locations shown on the Contract Drawings.

B. Construct curbing and edging in accordance with the details shown on the Contract Drawings.

1. The foundation for curb and edging shall consist of gravel spread upon the subgrade and after being thoroughly compacted shall be 6 inches in depth. The bottom of the curbstones shall be fully seated and supported on the compacted subgrade.

2. The joints between curbstones shall be carefully filled with cement mortar and neatly pointed on all exposed surfaces.

3. After pointing, the curbstones shall be cleaned of all excess mortar.

C. After curbing and edging is in place at the line and grade shown on the Contract Drawings backfill and compact equally on both sides with subbase course material as specified in Section 312000, Earth Moving. Compaction shall be by vibratory, hand-operated equipment and shall achieve the same density as specified for subbase course in Section 312000, Earth Moving.

3.4 SURFACE PREPARATION

A. Proof Roll the prepared subbase. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.

3.5 PLACING MIX

A. General: Spread bituminous concrete mixture on prepared surface, spread and strike-off. Spread mixture at minimum temperature of 225°F (107°C). Place inaccessible and small areas by hand. Place each course to required grade, cross-section, and compacted thickness. Protect all adjacent construction from staining with mix or damage by mechanical equipment. Clean, repair or replace any construction stained or damaged at no additional cost to the Owner.

B. Paver Operation: Spread bituminous in strips not less than 10-feet wide, unless otherwise acceptable to Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

C. Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density and smoothness as other sections of bituminous concrete course. Clean contact surfaces and apply Hot Poured Rubberized Asphalt Sealer.

D. Coat surfaces of watergate covers, gas gate covers, manhole covers and catch basin grates with a release agent to prevent bond with asphalt pavement.

E. The equipment for spreading bituminous concrete shall be mechanical, self-powered pavers capable of spreading and finishing the mixture true to line, grade, width, and crown by means of fully automated controls for both longitudinal and transverse slope.

F. The pavers shall operate while bituminous mixture is being spread at a speed that will produce a uniform surface texture free of any rippling or unevenness.

G. The mixtures shall be placed and compacted only at such times as to permit the proper inspection and checking by the Engineer or Owner’s Representative.

H. The mixtures shall only be placed in the work when they can be efficiently and satisfactorily placed by the methods stipulated herein. Unless otherwise permitted by the Engineer or Owner’s Representative for special conditions, only machine methods of placing shall be used.

I. No mixture shall be placed unless the breakdown and intermediate rolling can be completed by the time the material has cooled to 170°F and provided that the density of the completed pavement attains at least 95 percent of the laboratory compacted density.

J. The mixtures shall be placed only upon approved surfaces that are clean from foreign materials and dry and when weather conditions are suitable. The Engineer or Owner's Representative may, however, at the entire responsibility of the Contractor, permit work to continue when overtaken by sudden rain, but only with material that may be in transit from the plant at the time and then only when the temperature of the mixture is within the temperature limits specified and the existing surface on the roadway is not excessively wet.

K. The bituminous concrete shall be placed in course depths as shown in the Contract Drawings, as specified and as directed by the Engineer.

L. When an existing surface or new base upon which the bottom course is to be placed contains unsatisfactory irregularities, in the Engineer's or Owner's Representative's judgment, such irregularities shall be eliminated by an adequate placing and compaction of mixture so as to furnish a surface with true contour and grade before placing any specified course of mixture.

M. Special attention shall be given to proper testing of the surface of each course with a straightedge. The finished surfaces shall be even and uniform throughout.

N. Any mixture that becomes loose or broken, mixed with dirt, or in any way defective shall be removed and replaced with new mixture that shall be compacted to conform to the surrounding area. Areas of one square foot or more showing an excess of bitumen shall be removed and replaced.

O. Immediately after any course is screened and before roller compaction is started, the surface shall be checked, any irregularities adjusted, any accumulation from the screed removed by rake or lute, and all fat spots in any course removed and replaced with satisfactory material. Irregularities in alignment and grade along outside edges shall be corrected by the addition or removal of mixture before the edges are rolled. Indiscriminate casting of mix on the new screened surface, where irregularities are not evident, shall not be permitted.

P. Spreading by hand methods will be permitted only for particular locations in the work that, because of irregularity, inaccessibility, or other unavoidable obstacles, do not allow mechanical spreading and finishing.

3.6 ROLLING

A. General: Begin rolling when mixture will bear roller weight without excessive displacement.

B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

C. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling, and repair displaced areas by loosening and filling, if required, with hot material.

D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut-out such areas and fill with fresh, hot bituminous concrete. Compact by rolling to match the

surrounding surface density and smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked by wheel traffic.

I. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers. The rollers shall be steel wheeled supplemented with pneumatic-tired rollers where required or where permitted by the specifications, vibratory rollers.

J. Steel wheel rollers for initial and intermediate rolling shall have a weight of not less than 240 pounds per inch width of tread.

K. Each roller shall be operated by a competent, experienced roller operator and shall be kept in as nearly continuous operation as practicable while work is underway. The mixture shall be rolled longitudinally, diagonally, and transversely as may be necessary to produce the required contour for surface. Longitudinal rolling shall start at the side and proceed toward the center of the pavement, except on superelevated pavements where the rolling shall begin on the low side and progress to the high side, overlapping on successive trips by at least 12 inches. The rolling shall be continued and so executed that all roller marks, ridges, porous spots, and impressions are eliminated and the resulting surface has the required grade and contour. The motion of the rollers shall at all times be slow enough to avoid any displacement of the hot mixture. Any displacement or marring of the surface occurring as a result of reversing the direction of the rollers, or from any other cause, shall be corrected. To prevent adhesion with the mixture, the wheels of the steel rollers shall be kept lightly moistened with water, but excess water will not be permitted. The use of oil for this purpose will not be allowed.

L. Along curbs, structures, and all places not accessible with a roller, the mixture shall be thoroughly compacted with mechanical tamping devices. The surface of the mixture after compaction shall be smooth and true to the established line and grade.

M. Placing of the mixture shall be as nearly continuous as possible and the roller shall pass over the unprotected end of the newly placed mixture only when the placing of the course is to be discontinued for such length of time as would permit the mixture to attain initial stability. In all such cases, including the formation of joints, provision shall be made for proper bond with the new surface for the full specified depths of the courses.

N. The maximum length of longitudinal joint shall be such that the temperature of the mixture of the joint shall be not less than 200°F when abutting mixture is placed.

O. If the paving sequence or other conditions cause the joint temperature to fall below 200°F, the joint shall be treated prior to laying the next lane of bituminous concrete as follows:

1. The joint shall be coated with a hot poured rubberized asphalt sealant meeting the requirements of Federal Specification SS-S-1401 or SS-S-164.

P. Longitudinal and transverse joints shall be made in a careful manner, well bonded and sealed, and true to line and grade.

Q. In making joints along any adjoining edge, such as curb, gutter, or an adjoining pavement, and after the mixture is placed by the mechanical spreader, just enough of the hot material shall be placed by hand method to fill any space left open. These joints shall be properly “set-up” with the back of a rake at the proper height and level to receive the maximum compaction. The work of “setting-up” these

joints shall be performed only by competent workmen.

R. Where and as directed, the first width of any course shall be placed not less than 1 foot wider than the first width of top course and successive widths of top and as any other courses shall be so placed that there will be at least a 1-foot overlap between the joints in the top course and the other course.

S. The rolling of the successive widths of courses shall overlap and shall be performed so as to leave smooth, uniform joints and cross-sections.

3.7 PORTLAND CEMENT CONCRETE WALKWAYS

A. Areas to be paved shall be brought to subgrade elevation in accordance with the requirements of Section 312000, Earth Moving. The gravel borrow base course shall be placed and compacted in accordance with the requirements of Section 312000, Earth Moving to the compacted depth as indicated on the Contract Drawings. The base course shall be inspected and approved by the Owner's Representative before placement of concrete paving.

B. Edge forms and transverse forms shall be clean, smooth, free from warp, of sufficient strength to resist bowing out of shape, and of a depth equal to the thickness of the paving. Stake the forms in place to the proper alignment and grade. Clean forms after each use and coat with a release agent.

C. Deposit and spread concrete in a continuous operation between transverse joints. Concrete shall be placed in an alternate, every-other panel between transverse joints. Consolidate concrete with mechanical vibrating equipment supplemented by hand-spading, rodding, and tamping.

D. Screed surfaces with a straightedge and strike-off. Commence initial floating to form an open-textured and uniform surface plane.

E. Finish floating and troweling shall only be done after the bleed-water and water sheen have disappeared and the concrete surface has sufficiently stiffened. Tool edges of pavement at curbline and expansion joints with an edging tool with a radius of ⅛-inch.

F. After final floating steel trowel surface to true line and grade, all surface shall receive a light-to-medium broom finish perpendicular to the direction of travel.

G. Use an evaporation retarder if weather conditions are hot, dry, or windy. Surfaces shall be cured by completely covering with curing paper or with an application of a curing compound.

H. Expansion joint shall be located at 30-foot intervals perpendicular to the direction of travel and around all castings, fire hydrants, walls, buildings, and light pole bases within the walkway. Expansion joints shall be made with ⅜-inch-thick preformed filler material and sealed at the surface with light-gray colored joint sealant.

I. Control joints shall be spaced at 6-foot intervals to a depth of one quarter of the thickness of the concrete slab. Form joints with power-driven saws.

J. Construction joints shall be placed whenever placing on concrete is suspended for more than 30 minutes.

1. Butt joint with dowels or thickened edge joint shall be used If construction joints occurs at location of control joint.
2. Keyed joints with tiebars shall be used if the joint occurs at any other location.

K. STEEL REINFORCEMENT - Before being placed in position, reinforcing for reinforced concrete shall be thoroughly cleaned of debris.

3.8 CRACK SEALING

A. When indicated on the Contract Drawings, longitudinal and transverse bituminous concrete pavement cracks 0.2 inches in width and wider shall be routed, cleaned, and sealed.

B. Routing shall be accomplished with a power-driven self-propelled walk-behind pavement saw or router.

C. After routing, the cracks shall be cleaned of all debris with a strong stream of compressed air and allowed to dry. The air compressor shall be capable of furnishing a minimum of 90 pounds per square inch pressure at the nozzle.

D. The routed and cleaned crack channel shall be filled with a pourable, hot-applied, coal-tar emulsion asphalt sealer conforming to the minimum requirements of ASTM D3405. Application of the sealer shall be carefully controlled such that overpour does not spread onto adjoining pavement surfaces. The sealant shall be applied during the coolest part of the day, with reduced sunlight shining directly on the pavement to reduce the amount of expansion and contraction of the pavement.

E. Traffic shall be prohibited from crossing the work area until the sealant has completely hardened unless a non-tracking material is applied over the hot sealant.

3.9 PAVEMENT MARKINGS

A. The work under this Item shall be in conformance with Section 860 of the Standard Specifications and the Manual on Uniform Traffic Control Devices, current edition.

B. Cleaning: Sweep and clean surface thoroughly to remove loose material and dust. Markings shall be placed no earlier than 48 hours after the placement of the bituminous concrete top course and at temperatures above 45° F.

C. Apply paint with mechanical equipment to produce uniform straight edges. Lines to be applied at the width and color designated in the Contract Drawings. The Contractor shall establish reference lines for the proper layout of all markings. Apply in two coats at manufacturer's recommended rates. Furnish and place all barricades necessary to prevent tracking of wet paint by vehicles and pedestrians.

D. While the paint is still wet reflectorized glass beads shall be evenly applied at the rate of 6 pounds per gallon of paint.

3.10 FIELD QUALITY CONTROL

A. Test in-place asphalt and cement concrete courses for compliance with tolerance requirements. Repair or remove and replace unacceptable paving as directed by Engineer or Owner’s Representative. In-place surfaces will not be acceptable if exceeding the allowable variation from the following required tolerances:

1. Thickness: Plus ¼-inch.

2. Sidewalk Elevation: ⅛-inch, plus or minus.

3. Roadway Elevation: ¼-inch, plus or minus.

4. Expansion Joint Width: Plus ⅛-inch.

5. Surface: Gap below 10-foot-long straightedge, ⅛-inch.

B. The Contractor is responsible for ensuring that the grade at accessible curb cuts, sidewalks, and parking spaces does not exceed Massachusetts Architectural Access Board requirements CMR 521.

C. Compaction

1. The bituminous mixture shall be compacted to at least 95% of the density achieved on the laboratory testing of the design mix for the project.

2. Density will be checked by the Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods, ASTM 2950 at the Contractor's expense.

D. Guarantee: During the one year guarantee period, the Contractor shall maintain the surfacing and shall promptly fill with similar material in compliance with the above specifications, any depressions and holes that may occur so as to keep the surfacing in a safe and satisfactory condition for traffic.

END OF SECTION 321000

SECTION 32 1313

SITE CONCRETE

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide all labor, materials, equipment, services and transportation required to complete concrete work as shown on the Drawings and as specified herein or both.

a Concrete Walls.
b Concrete Stairs.
c Concrete Pavement Pedestrian.
d Concrete Pavement Pedestrian – Integral Color.
e Concrete Pavement – Vehicular.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Electrical – Section 26 0001
2 Earthwork - Section 31 2000
3 Finish Grading - 31 2219
4 Unit Paving – 32 1400
5 Miscellaneous Site Improvements - Section 32 3000
6 Cast-In-Place Concrete - Section 03 3000

1.04 REFERENCES

A Reference standards and specifications refer to Cast-In –Place Concrete Section 03 3000.

B Codes and Standards: Comply with provisions and codes, specifications and standards, except where more stringent requirements are shown or specified in Cast-In-Place Concrete Section 03 3000.

1.05 SUBMITTALS

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Product Data: Manufacturer's current catalogue cuts and specifications and suppliers material certificates for the following:

1 Cement concrete design mix

a 4000 PSI mix

2 Pre-molded expansion joint items

a Sealant.
b Pre-molded expansion joint.

3 Concrete curing compound

4 Welded wire mesh.

5 Steel wire.

6 Supports for reinforcement.

7 Dowels.

8 Dowel caps and dowels.

9 Integral colored concrete pigment(s).

10 Evaporation retarder.

C Certificates of Compliance

1 Reinforcing Steel: Certificate of compliance.

2 Concrete Mix Design: Ticket for each batch delivered showing the following:

a Mix identification.

b Weight of cement, aggregate, water, and admixtures, aggregate sizes/proportion, and air entrainment.

D Shop Drawings

1 Minimum 3/8" inch scale drawings showing dimensions, sizes, thickness, guages, finishes, joining, attachments and relationship of work to adjoining construction and existing conditions.

a Concrete Walls.
b Concrete Bands.

2 Coordinate all sleeves for utilities and other items and curbs and show them on the shop drawings.

1.06 TESTS

A Slump tests for cement concrete for each batch of concrete

1 Slump limits: Refer to Section 03 3000 Cast-In-Place Concrete.

1.07 QUALITY ASSURANCES

A Mock-Ups

1 The Contractor shall construct on site mock-up panels for each type of concrete finish to prototypically replicate the entire pattern, and concrete color(s) and showing all joints, finishes, saw cuts, score lines and expansion joints with sealant colors for approval by the Landscape Architect. The Contractor shall provide as many mock-ups that may be required to obtain approval from the Landscape Architect.

Note that the color of the cement, sands, and aggregates will be evaluated as part of the mock-up process. Mock-up samples may be required to provide comparisons of differing combinations of cement, sands, and aggregates.

2 Colored concrete mock-up and stamped colored concrete mock up(s): The contractor shall allow for up to three colors (from mfg. standard colors) to be mocked up for the selection of one color to be approved for use on the project. **The contractor shall allow in his schedule sufficient curing time for the cured color to be reviewed by the landscape architect (generally about 30 days).**

3 Mock-ups shall be provided for approval by the Landscape Architect prior to construction. Once approved, the mock-ups shall serve as the standard for the balance of the work and shall be protected against damage until final approval of the remaining work. The mock-up panels shall be removed at the end of construction of the concrete items and the specified materials be installed in place of the panels.

B Mock-up panels

1	Concrete walk	6' x 6'
2	Colored concrete walk	6' x 6'
3	Concrete wall	1' high x 6' long
4	Handicap ramp	1

1.08 PROJECT CONDITIONS

A Work notification: Notify Landscape Architect at least 48 hours prior to installation of concrete.

B Establish and maintain required lines, surfaces and elevations.

C Do not install concrete work over wet, saturated, muddy or frozen subgrade.

D Protect adjacent work.

1.09 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect's designated representative.

PART 2 – MATERIALS

2.01 STRUCTURAL FILL AND DENSE GRADED CRUSHED STONE: Refer to Section 31 2000 Earthwork for all requirements.

2.02 CONCRETE MIXES: 4000-PSI Mix for all Site Concrete including Vehicular and Pedestrian Paving. Refer to Cast-In-Place Concrete Section 03 3000.

2.03 FORM MATERIALS: Refer to Cast-In-Place Concrete Section 03 3000.

2.04 REINFORCING MATERIALS: Refer to Cast-In-Place Concrete Section 03 3000.

2.05 MISCELLANEOUS MATERIALS: Refer to Cast-In-Place Concrete Section 03 3000.

2.06 EXPANSION JOINT MATERIALS: Refer to Cast-In-Place Concrete Section 03 3000.

2.07 MIXTURE COMPONENTS

A Coloring Agent:

1 Type: Liquid or Powered integral color designed to color the cement paste in a concrete mixture.

2 Percentage: as recommended by supplier.

3 Product: Liquid or Powdered Integral color admixtures as produced by Schofield, 800-800-9900, www.scofield.com , Brickform, 800-483-9628, www.brickform.com or equal

4 Color: Two colors from the company standard color chart available from Schofield, Brickform or approved equal.

2.08 MISCELLANEOUS MATERIALS

A Preformed Expansion Joint Filler: Shall be 1/2" x depth of paving, ethafoam with 3/4" inch tear strip to be later replaced by sealant.

B Polyurethane Joint Sealant: Joint sealant shall be Sikaflex-2C cold-applied, two-component, moisture cured, non sag elastomeric joint sealing compound, or approved equal, suitable for use on horizontal joints. Color shall match concrete color.

C Concrete Curing Compound: VOCOMP 20 non-yellowing with a fugitive dye, visible only during installation or approved equal shall be the Concrete Curing Compound. The approved Concrete Curing Compound shall be compatible with the approved Concrete Sealer and/or the colored concrete admixtures.

D Dowel caps and dowels for attaching concrete slabs shall be hot dip galvanized and sized as shown on the drawings.

E Concrete Sealer: VOCOMP 25 non-yellowing with a fugitive dye, visible only during installation, or approved equal shall be the Concrete Sealer. The approved Concrete Sealer shall be compatible with the approved Concrete Curing Compound.

For colored concrete, the concrete sealer shall be chemically compatible with the color additives and be part of a “system” of products available from the colorant manufacturer.

F Backer Rod:

1 Type: Compressible polyethylene foam rod or other flexible, permanent, durable non-absorptive material as recommended by joint sealer manufacturer for compatibility with joint sealer.

2 Product: "Sonofoam Backer Rod" by Sonneborn Building Products, (612) 835-3434 or approved equal.

PART 3 – EXECUTION

3.01 PREPARATION

A Subgrade preparation and the installation of the Structural Fill and Dense Graded Crushed Stone shall be found under Section 31 2000 Earthwork, of these specifications. Subgrade shall be moistened as required to provide a uniform dampened condition at the time concrete is placed.

B Verify lines, levels and locations of formed concrete work. Verify that form dimensions comply with drawing dimensions.

3.02 FORMS: Refer to Cast-In-Place Concrete Section 03 3000.

3.03 PLACING REINFORCEMENT: Refer to Cast-In-Place Concrete Section 03 3000.

3.04 INSTALLATION OF EMBEDDED ITEMS: Refer to Cast-In-Place Concrete Section 03 3000.

3.05 PREPARATION OF FORM SURFACES: Refer to Cast-In-Place Concrete Section 03 3000.

3.06 INTREGAL COLORED CONCRETE

A Provide colorant in the proportions recommended by the manufacturer and as related to the approved mock-up. Each area of colored paving on the project shall be installed in continuous pours. Should more than 1 batch (truck load) be required to complete the area, the concrete color shall be consistent in formula with adjacent pour(s).

B Provide sealant at the rates of application and methods as recommended by the manufacturer. Follow the manufacturer’s recommendations as to the timing of the sealant application.

3.07 EXPANSION JOINTS

A Expansion joints shall be located as shown on the Drawings; at all interfaces of paving to walls, brick walls curbs, buildings, stairs, concrete benches, light pole bases, flagpole bases; and as directed by the Landscape Architect. Expansion joints are not required at the back of vehicular curbs at vehicular areas.

3.08 CONTROL JOINTS: Refer to the Drawings.

3.09 CONCRETE PLACEMENT: Refer to Cast-In-Place Concrete Section 03 3000.

3.10 CONCRETE SLAB FINISHING

A Preparation

1 After placing slabs, plane surface to the grades shown on the drawings. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushed brooms or rakes.

2 After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats or by hand-floating if area is small or inaccessible to power units. Float the surface with aluminum or magnesium floats after edging and jointing operations. Cut down high spots and fill low spots. Uniformly slope surfaces to drain. Immediately after leveling, refloat surface to a uniform, smooth, granular texture. Immediately following floating, the surface shall be steel-troweled.

3 All walks must be a maximum of 5%. Any discrepancies shall be brought to the attention of the landscape Architect before the installation of the paving.

4 Cross-slopes including but not limited to walkways, plazas, sidewalks, play surfaces, pedestrian paving, vehicular drop off area and handicap parking areas shall be graded at a maximum of 2 % cross slope. Any discrepancies shall be brought to the attention of the landscape Architect before the installation of the paving.

B Finishes

1 Concrete Walk, Colored Concrete Walk and Handicap Ramp - Light Broom Finish: After floating, achieve finish by dragging a fine bristle brush over the floated finish. No ‘picture frames’ are to show from edging the joints.

3.11 CONCRETE WALLS AND OTHER EXPOSED SITE CONCRETE FINISHING

A Sand Blast Finish.

1 Schedule: Perform sand-blasting no sooner than 10 days after pouring each section of concrete

2 Continuity: Perform in as continuous an operation as possible, utilizing the same work crew to maintain continuity of finish.

3 Depth of Cut: Use an abrasive grit of the proper type and gradation to expose the aggregate and surrounding matrix surfaces to be approx. 1/16 in. depth.

4 Backup Boards: Blast corners and edge of patterns carefully, using backup boards in order to maintain a uniform corner or edge line.

5 Uniformity: Use same nozzle, nozzle pressure and blasting technique as used for sample panel.

6 Control: Maintain control of abrasive grit and concrete dust in each area of blasting.

7 Clean Up: Remove all expended abrasive grit, concrete dust and debris at the end of each day of blasting operations.

3.12 CONCRETE CURING AND PROTECTION: Refer to Cast-In-Place Concrete Section 03 3000.

3.13 REMOVAL OF FORMS: Refer to Cast-In-Place Concrete Section 03 3000.

3.14 MISCELLANEOUS CONCRETE ITEMS

A Filling-In: Fill-in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

3.15 MINOR CONCRETE SURFACE REPAIRS

A Patching of defective areas will be determined by the Landscape Architect prior to any patching. Only minor patching will be allowed where approved by the Landscape Architect.

1 Work determined to be unacceptable and in excess of minor patching as determined by the Landscape Architect shall be removed and replaced by the Contractor to the satisfaction of the Landscape Architect at no additional expense to the Owner.

B Minor Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Landscape Architect. All voids and cavities on all surfaces shall be completely filled with stiff mortar of same composition and air-entrainment as the mortar in the original concrete mix. The same brand and color of cement, and the same kind and color of fine aggregate used in the original concrete shall be used in this mortar. The mortar shall be mixed, allowed to set for thirty (30) minutes and then remixed before placing in the work. Carefully remove surface film from these pointed areas before the mortar sets. If surfaces exposed to view do not present a uniformly smooth, clean surface of even texture and appearance when prepared in accordance with foregoing, they shall be rubbed to obtain a satisfactory finish. Surfaces shall be wetted with clean water and rubbed with a carborundum brick without applying any cement or other coating until smooth and uniform in appearance.

C Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired by the Contractor to satisfaction of Landscape Architect at no additional expense to the Owner.

1 Surface Repair Items: Surface defects, as such as but not limited to include color and texture irregularities, cracks, spalls, honey combing, rock pockets, fins and other projections on surface and stains that cannot be removed by cleaning and other conditions as determined by the Landscape Architect.

D Repair methods not specified above may be used, subject to acceptance of Landscape Architect.

END OF SECTION

SECTION 32 3000

MISCELLANEOUS SITE IMPROVEMENTS

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide all labor, materials, equipment, services and transportation required to complete miscellaneous site improvements work as shown on the Drawings and as specified herein or both.

a Trash and Recycling Receptacles.
b Benches.
c Custom Benches.
d Bicycle Racks.
e Stainless Steel Bollards.
f Decorative Gravel.
g Flagpole.
h Natural Stone Boulders.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Work to be performed under the designated Sections:

1 Electrical – Section 26 0001
2 Earthwork - Section 31 2000
3 Finish Grading - Section 31 2219
4 Planting - Section 32 9000
5 Site Concrete - Section 32 1313

1.04 SUBMITTALS

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Product Data: Manufacturer's current catalogue cuts and specifications and suppliers material certificates for the following:

1 Trash and Recycling Receptacles.
2 Custom Benches.
3 Benches.

4 Bicycle Racks.
5 Stainless Steel Bollards.
6 Decorative Gravel.
7 Flagpole.
8 Natural Stone Boulder Photographs

C Samples

1 Paint and finish for all items.

D Shop Drawings

1 Minimum 3/8 inch scale showing dimensions, sizes, thickness, gauges, finishes, joining, attachments and relationships of work to adjoining construction and existing conditions.

a Trash and Recycling Receptacle.
b Benches.
c Bicycle Racks.
d Stainless Steel Bollards.
e Flagpole.

2 Do no final sizing or finishing until shop drawings and samples for that item of work is approved.

1.05 REFERENCES

A ASTM - American Society for Testing and Materials.

1.06 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect's designated representative.

PART 2 – MATERIALS

2.01 DENSE GRADED CRUSHED STONE AND STRUCTURAL FILL: REFER TO SECTION 31 2000 Earthwork for all requirements.

2.02 CEMENT CONCRETE

A Cement Concrete for footings shall be the 4,000 PSI Mix. Refer to Section 32 1313 Site Concrete for all requirements.

2.03 TRASH AND RECYCLING RECEPTACLES (Provide 6 Trash and 6 Recycling Receptacles)

A Acceptable Manufacturers: Provide products which meet or exceed the requirements of these specifications from one of the following manufacturers.

1 Chase Park trash receptacle, side opening, 24” x 40”, surface mounted with 36 gallon ridged plastic liner. Aluminum polyester powdercoat. Appropriate graphics indicating litter and recycling on each receptacle. Color to be selected

from standard color chart by the Architect, manufactured by Landscape Forms, 800-381-3455.

2 Retropolitan litter and trash receptacle, surface mounted, Model RTR-LS-36-EL-SS #4 satin-DT with 36 gallon rigid plastic liner and appropriate graphics indicating litter and recycling on each receptacle manufactured by Creative Pipe Inc, (800) 644-8467.

3 Dispatch single stream litter and recycling receptacles, surface mounted, with F+S optional colors to be selected by the Architect, with 45 gallon ridged plastic liner. Appropriate graphics indicating litter and recycling on each receptacle. Manufactured by Form+Surfaces 800-451-0410.

B Manufacturing Requirements: Provide all trash receptacles as a complete unit produced by the same manufacturer only including the receptacle, liner and finishes and all attachments as shown on the drawings or specified herein.

2.04 BICYCLE RACKS (To accommodate 70 bicycles)

A Acceptable Manufacturers: Provide products which meet or exceed the requirements of these specifications from one of the following manufacturers.

1 32 - Model: bola, stainless steel tubing with #4 satin finish, embedded. by Landscape Forms, 800-381-3455.

2 32 -Model: ring, stainless steel tubing with #4 satin finish, embedded. by Landscape Forms, 800-381-3455.

3 32 - Horseshow bike rack HS2-F-SS, embedded by Creative Pipe Inc, (800) 644-8467.

B Manufacturing Requirements: Provide all bicycle racks as a complete unit produced by the same manufacturer only including all attachments as shown on the drawings or specified herein.

2.05 STAINLESS STEEL BOLLARDS

A Acceptable Manufacturers: Provide products which meet or exceed the requirements of these specifications.

1 12” diameter x 3’ exposed 316 surgical stainless steel schedule 40, .322 wall, stainless steel pipe with flat top as shown on the drawings.

2 Mounting: Permanent embedded and removable embedded bollards with lock tab and lock as shown on the drawings.

3 Finish: Stainless steel with #4 Satin finish.

2.06 DECORATIVE GRAVEL

A Gravel 1-1/2” – 2” rounded washed clean stone, grayish as selected by the Landscape Architect.

B Edging: Material: Permaloc Corporation, Holland, MI 800-356-9660 or approved equal.

1 Model: “AsphaltEdge” – with sliding aluminum connectors for splicing. Color to be black electrostatically applied, baked-on, acrylic paint.

2 Accessories: 3/8” x 10” spiral steel spike available from edge restraint supplier.

C Filter Fabric: Mirafi # 140.

2.07 FLAGPOLE

A Acceptable manufacturers: Provide products which meet or exceeds the requirements of this equipment by Concord Industries Inc. 800-527-3902, Admiral Flagpoles, Inc. 800-783-7653 or American Flagpoles, 800-368-3090.

B Manufacturing Requirements: Provide all flagpoles as a complete unit produced by the same manufacturer, including pole fittings, accessories, bases and anchoring devices and all other components as shown on the drawings or specified herein.

1 Provide flagpoles and installations to withstand a wind velocity of 120 MPH when flying a flag of 8 feet x 12 feet.

C Materials:

1 Poles: Concealed halyard, single piece cone-tapered aluminum flagpole of seamless extruded tubing.

a Aluminum: Comply with ASTM B 241, alloy 6063-T6, having a minimum wall thickness and tensile strength of not less than 30,000 psi.

b Pole Description:

Exposed Height: 40 feet
Butt Diameter: 8 inches
Wall Thickness: 0.188 inches

c Pole Mounting: Mounting shall be embedded (Ground Set).

1) Steel foundation sleeve shall be corrugated 16 gage galvanized steel tube.

2) Steel base plate and ground spike shall be galvanized steel and dimensioned as shown on the drawings.

3) Spun aluminum pole flash collar, finished to match the flagpole shaft and sized to meet the manufacturers requirements for the selected pole sleeve.

4) Sand as required by the manufacturer.

5) 4 - Steel Wedges: Weld to sleeve at 90-degree angles to the center of the flagpole.

6) 4- Hardwood Wedges.

7) Sealant shall be polyurethane joint sealant as specified in Section 03400 Site Concrete.

d Pole shaft and pole flash color finish shall be the manufacturer's standard finish such as, deep luster finish.

e Fittings and Accessories

1) Truck shall be a cast aluminum, internal halyard type, revolving, non-fouling.

2) Halyard shall be concealed internal halyard system with stainless steel cable sized to accommodate the specified maximum flag size, 2 swivel-snaps, counter weight, and retainer ring.

3) Winch shall be mounted inside the pole and protected by a locked door.

2.08 NATURAL STONE BOULDERS

A Local, natural New England fieldstone boulders.

B Sizes as shown on the drawings.

2.09 BENCH (6 total)

A Acceptable Manufacturers: Provide products which meet or exceed the requirements of these specifications from one of the following manufacturers.

1 Scarborough bench, 72" length with back, arms and center arm. Landscape Forms. 800-381-3455. Aluminum polyester powdercoat. Color to be selected from standard color chart by the Architect, manufactured by Landscape Forms, 800-381-3455.

2 Winchester, rod, 72" length with back and arms, surface mount. Powdercoat aluminum from standard color chart by the Architect as manufactured by Urbanscapesfurniture.com.

3 Persidio straight three-unit bench, no arms, 69" length with back, embedded, by Landscape Forms. 800-381-3455. Aluminum polyester powdercoat. Color to be selected from standard color chart by the Architect, manufactured by Landscape Forms, 800-381-3455.

B Manufacturing Requirements: Provide benches as complete units produced by the same manufacturer.

PART 3 - EXECUTION

3.01 TRASH AND RECYCLING RECEPTACLE

A Installation shall be surface mounted as recommended by the manufacturer.

B Provide touch up paint as necessary to match the manufacturers.

3.02 BENCHES

A Assembly and installation shall be per the manufacturer's instructions and as specified herein.

B Install embedded items into the paving surface and install the bench as per the manufacture's instructions.

C Use manufacturer's provided paint for touching up all chips and scratches.

3.03 BICYCLE RACK

A Installation shall be as shown on the drawings and as specified by the manufacturer an as specified herein.

B The bicycle rack shall be installed plumb and set to the grade(s).

C Provide touch up paint as necessary to match the manufacturers.

3.04 STAINLESS STEEL BOLLARDS

A Assembly and installation shall be per the manufacturer's instructions and as specified herein. All products shall be plumb and set to the grades shown on the drawings.

3.05 DECORATIVE GRAVEL

A Installation shall be as shown on the drawings.

3.06 FLAGPOLE

A Installation shall be as per the manufacturer's instructions, as shown on the shop drawings and as specified herein. The goal, flagpoles and cage shall be plumb and set to the grades shown on the drawings.

B Excavation for footings, backfill and compaction shall be as specified in Site Grading and Excavation.

C Install the concrete footing as specified in Cast in Place Concrete.

3.07 NATURAL STONE BOULDERS

A Installation shall be as shown on the drawings and as specified herein.

END OF SECTION

SECTION 32 9000

PLANTING

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide all labor, materials, equipment, services and transportation required to complete planting work as shown on the Drawings and as specified herein or both.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Work to be performed under the designated Sections:

1 Earthwork - Section 31 2000
2 Finish Grading - Section 31 2219
3 Soil Preparation - Section 32 9113
4 Landscape Maintenance - Section 31 0125

1.04 REFERENCES

A "American Standard for Nursery Stock", 1986 Edition, American Association of Nurserymen, Inc.

1 The Contractor shall have a copy of this with him for all nursery visits and on site at all times.

B "Hortus III", 1976 Edition, Bailey Hortorium, Cornell University.

C "Arboriculture", Harris, R.W., Prentice Hall, Inc., New Jersey, 1983.

1.05 SUBMITTALS

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Plant Materials Review

1 Within 30 days after the Award of the Contract, the Contractor shall submit a complete list of all plant materials proposed. The list shall include: Scientific names of plants, size and quantity of plants available for review, location of growing grounds or nursery, and the suppliers name, phone number, address, and contact person.

a The Contractor shall also submit at this time color photographic prints of each plant proposed. A scale element or person of a known height shall appear in each photograph.

b The Contractor shall also submit at this time attached Letter(s) of Certification from each nursery or the supplier listing the stock available for review attesting that the stock to be reviewed for selection is the specified plant stock meeting all the sizing and all other specified requirements and that these plants are free from disease, insect infestation or damage.

2 **Substitutions: There will be no substitutions for the plants, plant species and variety.**

3 Field Collected Plant Material: If the contractor finds that some plant materials are only available from non-nursery sources, the Landscape Architect will consider whether these can be used in the work. The Contractor shall submit written data, the same as for Unavailable Material, listing all nurseries and sources he contacted.

a All conditions specified under Unavailable Material not changed by this item shall apply for substitutions and larger and smaller plants.

b If the Landscape Architect elects to consider these plants, all requirements for nursery grown plants shall apply.

4 The Landscape Architect based upon his review of the plant photograph submission(s) will determine if, in his judgment the plants are acceptable for field review at the nursery.

a The Landscape Architect reserves the right to provisionally accept the plant material from the photograph without his inspection at the nursery if he deems it is in the best interest of the project to do so.

1) If these provisionally accepted plants do not meet the requirements of this specification in the opinion of the Landscape Architect when he reviews them on site prior to planting, the Contractor shall remove them from the site at no additional cost to the Owner and immediately

find replacement plants which meet the requirements of this Specification. The Contractor will then arrange for plant review as specified herein.

b The Landscape Architect may field review and tag all acceptable proposed plant materials at the nursery. Such approval shall not impair the Landscape Architect's right of inspection and rejection of any plants at any time during the progress of the work which do not meet the requirements of this Specification.

5 Nursery Inspection: The Contractor shall accompany the Landscape Architect to all reviews of plant materials at the nursery. The Landscape Architect may review and tag plants at place of growth and upon delivery to the site (if he wishes) for conformity to the Specifications.

a The Landscape Architect's acceptance of the plants at this time shall not impair his right of inspection and rejection of any plants at any time during the progress of the work which do not meet the requirements of the Specifications.

b The Contractor shall have a copy(s) of the specified Planting Digging at the Nursery to give to each Nursery from which plant material is purchased.

1) The Contractor shall explain these requirements to each Nursery and Identify the required Nursery or Growers Written Certification.

6 If the plant material at the nursery(s) in found to be unacceptable in the opinion of the Landscape Architect, the Contractor shall at his expense find the plants required and arrange with the Landscape Architect’s review of the plant material.

a This sequence of plant finding, review and approval or rejection and review again for approval shall continue until all plants have been accepted by the Landscape Architect.

7 The Contractor shall be solely responsible for the purchase of the accepted plant materials from the supplier or nursery.

8 Special Conditions: The above provisions shall not relieve Contractor of the responsibility of obtaining specified materials in advance if special growing conditions or other arrangements must be made in order to supply specified materials.

B Product Data: Manufacturer's current catalog cuts and specifications of the following:

1 Mulch

2 Top dress fertilizer

3 Fertilizer tablets.

4 Anti-desiccant.

5 Jute mesh.

C Samples

1 Fertilizer tablets.

2 Mulch: One (1) pint.

D Certificates

1 Nursery or Grower's Written Certification (s) of Root Crown (flare exposure).

2 Written Certification from the Grower and Contractor that the plants are true to species and variety.

E Tests

1 Plant Pit Percolation Tests

1.06 DELIVERY, STORAGE, AND HANDLING OF PLANT MATERIALS

A Delivery: Deliver, store and handle materials to the site in such a way that they will not be damaged. Do not deliver to the site disease-infected plant materials.

B Labeling: Provide legible waterproof labels for all plants and attach them at the nursery. The labels shall have the correct genus and species and Common Name and the name of the grower or nursery form, which it was purchased.

C Certificates of Inspection: As required by law for transportation of each shipment of plants along with invoice.

D Storage: Protect containered plants from sun during summer months with temperatures above 80 degrees F. Keep plants that cannot be planted immediately upon delivery in the shade, well protected and well watered.

E Handling

1 Do not lift or handle plants by tops, stems or trunk at any time. Do not pull or bend or handle plants with wire (except wrapped rootball of field dug plants).

2 Lift plants by supporting rootball bottom or container bottom.

3 Do not throw or drop any plants from trucks or other equipment.

4 Any damaged plants including plants with broken balls or cracked containers will be rejected and immediately replaced with matching plants.

F Anti-Desiccant: At Contractor's option, and immediately before transporting, spray deciduous plant materials in full leaf or evergreens with anti-desiccant. Apply an adequate film over trunks, branches, twigs and foliage.

1.07 PLANT DIGGING AT THE NURSERY

A All overburden soil, if any is present, shall be removed from all tree and shrub rootballs prior to digging.

1 The depth of this overburden soil shall be determined by excavating down at the plants trunk(s) until the root flare is exposed.

a The root crown (flare) is the point at which the roots begin to flare out from each plants trunk(s)

b The Contractor shall not accept any plants for shipping which have not had all overburden soil removed and root balls of the incorrect sizes.

c The Landscape Architect will reject any plants which have overburden soil unremoved and rootball(s) of incorrect sizes.

d The rejected plants shall be immediately replaced by the Contractor with matching specified plants at no additional cost to the Owner.

B Field Dug Stock:

1 Prior to digging of field grown plant materials, insure that excess loose fill resulting from cultivation around stems and over roots be removed down to natural finish grade at crown of plant materials. During digging, verify that size of tree spade or other equipment is adequate to encompass the actively growing root zone of all plants. Plants, which, after digging, show mostly large fleshy roots and few fibrous roots, will be rejected.

2 Dig B&B plants with firm, natural balls of earth of diameter not less than that recommended by the American Standard for Nursery Stock, and of sufficient depth to include the fibrous and feeding roots. Wrap and tie as required to prevent all cracking or loss of soil from routable.

C The Contractor shall inspect all plants at the Nursery after digging and prior to shipping and shall determine that they meet all the requirements of these Specifications and reject any that do not.

1 The Contractor shall immediately provide replacement plants meeting these Specifications that match those rejected at no additional cost to the Owner.

1.08 SEQUENCING AND SCHEDULING

A The following sequencing and scheduling is general only and does not list all the items of work:

1 Refer to Section 32 91 13 Soil Preparation PART 3 INSTALLATION for scarification, subsoil amending, where shown on the Drawings, plant backfill mix (on grade) requirements and other requirements.

a On-Grade Planting Sequencing

1) Rough grading
2) Scarification
3) Layout trees and shrubs for approval
4) Excavate plant pits and beds
5) Test Tree Pits for drainage
6) Amend Subsoil (if required by the approved Soil Tests)
7) Install and amended plant backfill mix
8) Finish Grade
9) Plant materials installation
10) Fine grade and repair plant saucers

B Coordination: Coordinate with work of other sections to insure the following sequence of events:

Pruning: Do not prune plant materials until after installation.

C Planting Seasons: All plant material shall be planted during the Spring or Fall planting season as indicated below. No planting shall be performed in frozen ground or when snow covers the ground. The Landscape Architect may suspend work when soil or weather conditions are unsuitable for planting operations.

1 Deciduous Trees and Shrubs which are Balled and Burlapped and or Container Material, and Evergreen Shrubs which are Container Material

Spring: March 1 to June 15
Fall: September 1 to December 1

2 Evergreen Shrubs that are Balled and Burlapped:

Spring: April 1 to May 15
Fall: August 15 to October 30

3 Evergreen Trees:

Spring: April 1 to May 15
Fall: August 15 to October 30

4 Special Conditions: If special conditions exist which may warrant a variance in the above conditions or dates, a written request shall be submitted to the Landscape Architect stating the conditions and proposed variance. Permission for the variance shall be given if in the opinion of the Landscape Architect if the variance is warranted.

1.09 WARRANTY

A Warrant that all plants (except annuals) planted under this Contract will be healthy and in flourishing condition of active growth one (1) year after the date of Acceptance of the 90 Day Maintenance.

B Correct Species: Warrant that all plant materials are true to species and variety.

C Delays: Delays caused by the Contractor in completing planting operations which extend the planting into more than one planting season shall extend the Warranty Period correspondingly.

D Condition of Plants: Plants shall be free of dead or dying branches and branch tips, with foliage of normal density, size and color.

E Replacements: As soon as weather conditions permit, replace, without cost to Owner all dead plants and all plants not in a vigorous, thriving condition, as determined by Landscape Architect during and at the end of Warranty Period.

F Exclusions: Contractor shall not be held responsible for failures due to neglect by Owner, vandalism, and acts of God, during Warranty Period. Report such conditions.

1.10 MAINTENANCE AND PROTECTION OF PLANTS UNTIL THEIR ACCEPTANCE AT THE PRELIMINARY REVIEW

A Maintenance shall begin immediately after the installation of each plant.

1 Refer to Section 31 0125 Landscape Maintenance for requirements.

1.11 90 DAY MAINTENANCE PERIOD AND FINAL ACCEPTANCE

A Refer to Section 31 0125 Landscape Maintenance for these requirements.

1.12 REPLACEMENTS

A Failed Materials

1 Replace at no cost to the Owner all plant materials exhibiting conditions which are determined as unacceptable by the landscape architect.

2 Replacements shall be the same species. Apply all requirements of this Specification and drawings to replacements.

3 Contractor shall be held responsible for a maximum of one (1) replacement for each failed tree, shrub and vine, and same area of groundcover planting after final acceptance during warranty period.

B Incorrect Materials

1 During Warranty Period, replace at no cost to Owner plants revealed as being untrue to name and species.

2 Provide replacements of a size and quality to match the planted materials at the time the mistake is discovered.

1.13 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect's designated representative.

PART 2 – PRODUCTS

2.01 MATERIALS

A Plant Materials

1 Verify that all container stock (excluding annuals) has been grown in the containers in which delivered for at least one growing season, but not over two (2) years.

2 Growing Conditions: Plants shall be nursery-grown in accordance with good horticultural practices under climatic conditions similar to those of project for at least two years unless otherwise specifically authorized.

3 Appearance: Trees and shrubs shall be exceptionally heavy, symmetrical (as applicable to the species), tightly knit, and so trained or favored in development and appearance as to be superior in form for their species, with regard to number of branches, compactness and symmetry and other applicable standards specified in the American Standard for Nursery Stock for the species and size of plants in the Contract.

4 Vigor: Plants shall be sound, healthy and vigorous, well branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs, or larvae. They shall have healthy, well-developed root systems. Plants shall be free from physical damage or adverse conditions which would prevent thriving growth.

B Condition of Root System: Samples must prove to be completely free of circling, kinked or girdling trunk surface and center roots and as applicable show no evidence of a pot-bound condition. Upon inspection by Landscape Architect at the job site, if five (5) percent or more of the plants of each species are found to contain kinked, circling or girdling roots, all plants of that species will be rejected.

C Measurements

1 Refer to the American Standards for Nursery Stock for applicable standards not specified herein.

2 General: Take caliper measurement at a point on the trunk 6 in. above natural ground line for trees up to 4 in. in caliper (and at a point 12 in. above the natural ground line for trees over 4 inches in caliper.)

a Measure foliage across mean foliage dimension when branches are in their normal upright position. Foliage origin along main trunk shall be measured from soil line.

b Height and spread dimensions specified refer to main body of plant and not branch tip to tip. Properly trimmed plants shall measure the same in any direction. If a plant is unevenly grown, it shall be classified in the size category of the smallest dimension.

3 Size Range: If a range of size is given, do not use plant materials less than the minimum size. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required. Plants that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected.

4 Substitutions

a Refer to SUBMITTALS of this Section - 32 9000 Plant Materials, for Substitution requirements.

D Unacceptable Trees: Trees having such items, as but not limited to, the following will be rejected:

1 Nonconformance to the specifications.

2 Damaged or crooked leaders or other damage.

3 Main leader headed back.

4 Abrasions of the bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 3/4 inch diameter which have not completely callused.

5 Plant disease, nutrient or other stress.

E Pruning: Do not prune plants until after installation. See Section 31 0125 - Landscape Maintenance for time of pruning, pruning requirements, and review at the time of pruning by the Landscape Architect.

F Refer to Item 1.06 PLANT DIGGING AT THE NURSERY of this Section - 32 9000 Planting for other applicable plant material requirements.

2.02 MIXES

A Backfill Mix for Plant Pits: See Section 32 9113 - Soil Preparation.

2.03 ACCESSORIES

A Pine Bark Mulch:

1 Pine bark mulch shall be derived from evergreen tree bark aged a minimum of (6) months and no more than (18) months. The bark shall be shredded so that the resulting pieces are no more than (1/4) inch thick and no longer than (3) inches. The mulch shall be free of stringy materials and shall not contain an excess of fine particles. The mulch shall be dark brown in color, free of leaves, twigs, sod, weeds, shavings, and other foreign materials which are injurious to healthy plant growth.

B Water

1 Clean, fresh and potable.

2 Transport as required.

C Anti-Desiccant: (Used for retarding excessive loss of plant moisture and inhibiting wilt)

1 Type: Sprayable, water-soluble vinyl-vinyledine complex which will produce a moisture-retarding barrier not removable by rain or snow.

2 Product "transfilm" by P.B.I./Gordon Corporation, (816) 421-4070, or equal.

2.04 COMMERCIAL FERTILIZER TABLETS

A Commercial Fertilizers for Trees, Shrubs and Vines shall be Slow-release Fertilizer Tablet: "Agriform" 21 gram tablets with 20-10-5 (N-P-K) by Sierra Chemical Co., (408) 263-8080, or equal.

2.05 PROTECTIVE COVERINGS

A Product: Refer to Section 31 2500 – Erosion Control for jute mesh.

PART 3 – EXECUTION

3.01 EXAMINATION

A Verification of Conditions

1 Finish Grades: Finish grades for planting areas shall have been established in another Section. Verify that all grades are within 1 in. plus or minus of required finish grade.

2 Soil Preparation: Do not commence planting work prior to completion and acceptance of soil preparation. See Section 32 9113 Soil Preparation.

3.02 LAYOUT

A Layout and Staking: Lay out plants at locations shown on Drawings. Use (3) foot lath, or wire flag, color-coded for each specie of plant material.

3.03 LANDSCAPE ARCHITECTS FIELD REVIEW OF PLANT AND PLANT BED LOCATIONS AND CONFIGURATIONS

A Locations of the Contractor's stakes and plant bed layout will be checked in the field by the Landscape Architect with the Contractor and will be adjusted by the Contractor to the Landscape Architects satisfaction to exact position before planting begins. Right is reserved to refuse review at this time if, in the Landscape Architect's opinion, an insufficient quantity of plants is available to be planted.

3.04 DIGGING PLANT PITS AND PLANT BEDS

A Digging Plant Pits: Dig tree pits only after the finished subgrade has been approved as shown on the Drawings and described herein. For on grade trees scarify all sides and bottoms of the tree pit after excavation and do any on grade subgrade amending required by the Soils Testing Report.

B Shrub pits and beds and Groundcover and perennial beds shall be dug only after the finished subgrade has been approved as shown on the Drawings and described herein. For on grade pits and beds, scarify the beds' sides and bottoms and do any on grade subgrade amending required by the Soils Testing Report.

C Containerized Plant Pits: Excavate round plant pits as shown on the Drawings:

D Ball and Burlap Plant Pits: Excavate round plant pits as shown on the Drawings:

3.05 OBSTRUCTIONS IN PLANT PIT(S) OR PLANTING BED(S)

A Obstructions: If rock, underground construction work, main tree roots or other obstructions are encountered in the excavation of the plant pits which may not be able to be removed or are the work of others, the Contractor shall stop digging that pit or bed and immediately contact the Landscape Architect with a full written explanation of the nature of the obstruction.

1 The Landscape Architect will determine if the object(s) encountered are such that they can be removed.

a If the Landscape Architect determines that the object (s) could be removed, the Contractor shall submit a proposal for the Landscape Architects and the Owner's review consideration for approval for the cost of the object(s) removal prior to doing any work.

b If the object can not be removed or the cost is too much to remove, as determined by the review of the Owner, and the Landscape Architect. The Landscape Architect will either select an alternate location for the plant pit plant bed location(s), or plant bed configuration(s), or he will require a credit from the Contractor for the Plants not installed.

1) If the Landscape Architect determines that an Alternative location for the plant can be done, the Contractor will submit his costs for the plant pit or plant bed work done to the point of finding the obstruction and the cost for backfilling the pit, and or, the plant bed to meet the requirements of the work and any additional requirements as determined by the Landscape Architect.

3.06 DRAINAGE TEST(S) OF PLANT PITS FOR TREES, SHRUBS, AND GENERAL PLANT BED TESTS FOR EACH GROUNDCOVER AND PERENNIAL BED

A Plant Percolation tests for Trees not underdrained.

1 10 Tree pit shall be tested in areas selected by the Landscape Architect.

2 Tree Pit Testing Procedure

a Dig test pit the size specified for each tree pit. Legibly calibrate a stake at (1) inch intervals into the bottom of the pit.

b Fill the test pit with water to within (1) foot of the finish grade. Immediately record the water level on the stake.

c After 3 hours, record the water level again. Repeat recording of the water level once each hour for the succeeding 5 hours.

d Water level drop ratings:

1) Acceptable rate = 2 inches /hour or more

2) Marginal rate = 1 to 2 inches/ hour

3) Unacceptable rate = Less than 1 inch / hour

3 Shrub and Groundcover and perennial beds: For each shrub or groundcover bed dig and test four on-grade pits sized for each plant species in each bed at location(s) as determined by the Landscape Architect in the field.

a Locate a water measure stick marked the same as for tree pits in each pit to be tested.

b Water level drop ratings shall be recorded the same way as noted for tree pits.

4 Test all plant pits twice in succession.

5 Written test results

a Provide a list of all water drop levels for all plant pits tested.

b Provide written notification of conditions permitting the retention of water in plant pits for more than 24 hours and provide the location of these pits and all other tested pits on a plan.

6 Restrictions: Do not perform tests of a rainy day (or during freezing weather) of when the ground is frozen or the soil is saturated with water. Repeat all tests interrupted by water soil saturation, rain, frozen ground, and freezing temperatures.

7 Documentation: Submit written documentation of all test pit percolation results, dated and signed by the tester.

a The Landscape Architect will determine which pits are acceptable for planting.

b The Landscape Architect will determine if the plant(s) pits or plant beds

can be relocated to an area that does not require underdrainage, or if they can not be relocated and not could be acceptably underdrained in place, or if they can not be acceptably underdrained the Landscape Architect will request a credit for the applicable plants as specified.

c Plant Relocation Option

1) If the Landscape Architect determines that the plants(s) could be relocated to an area that drains, the Landscape Architect will select the area(s)for relocation. The Contractor shall submit a proposal for the Landscape Architects and the Owner's review consideration for approval for the cost of the object(s) removal and relocation prior to doing any work.

2) If the plant can not be relocated or the cost is too much to relocate AS DETERMINED BY REVIEW OF THE OWNER AND THE LANDSCAPE ARCHITECT, the Landscape Architect will require a credit from the Contractor.

d Plant Underdrainage in Original Location Option

1) If the Landscape Architect determines that the plant should remain in place if it can be underdrained in a manner that the cost is acceptable to the Owner, the Landscape Architect and the Contractor will discuss underdrainage options. The Landscape Architect will consider these options and prepare any of these or other options for the Contractor to price to correct the need for underdrainage. The Contractor shall submit the pricing for the Landscape Architect's and the Owner’s review and consideration for approval before doing the work.

2) If the Cost is too much in the opinion of the Landscape Architect and the Owner, They will consider other options and the Contractor's Recommendations to resolve the underdrainage issue They will inform the Contractor of their conclusions for him to price for his incorporation into the work, or they will request a credit from the Contractor.

3.07 TREE SHRUB AND VINE PLANTING

A Handling and De-potting of Plant Materials

1 Damage: Avoid damage to containerized root masses and rootballs. If rootball or containerized root mass is cracked or broken or the trunk loose in the ball or container during handling and de-potting, plant will be rejected. Do not remove plant from container prior to completion of plant pit preparation.

2 Containerized Plants

a Canned Shrubs: Metal Containers: Cut can on two sides with accepted cutting tool. Do not use spade.:

b Plastic Containers: Tip container to horizontal orientation and shake carefully to remove the root mass and the plant. Support rootball and the root mass during installation to prevent cracking or shedding of soil.

3 Balled and Burlapped Plants: Lift and carry by bottom of the root ball or containerized root mass only. Do not remove wrapping until plant is set in plant pit. Cut all wire and peel wire and wrapping away from upper 1/3 of rootball prior to backfilling.

a Plastic or otherwise indecomposable burlap or other undecompostable root ball covering materials shall not be used.

B Installation

1 Refer to the Drawings for the planting details and locations for the plants.

2 Containerized Root Mass Scarification

a After removing plant and its containerized root mass from the container, scarify the sides of the rootball to a depth of 1 in. at four to six equally-spaced locations around the perimeter of the root mass or at 12 in. intervals on sides of boxed materials. Cut and remove circling roots over 3/8 in. diameter.

b Shrub and Vine Pit Depths: Confirm the depth of each shrub and vine pit by setting the root crown 1- inch above the finish grade as shown on the Drawings.

1) If any pits are over excavated, add and foot or hand tamp compact backfill mix at the bottom of the pit or bed to correct the level of over excavation.

3 Plant Pit Side Scarification: Scarify sides of plant pit, thoroughly breaking up surfaces and eliminating "glazed" areas.

4 Tree Shrub and Vine Positioning: Position the plant in the planting bed and or pit as shown on the Drawings maintaining a plumb condition throughout all planting operations.

5 Tree Shrub and Vine Pit Depths

a Shrub and Vine Pit Depths: Confirm the depth of each shrub and vine pit by setting the root crown 1- inch above the finish grade as shown on the Drawings.

1) If any pits are over excavated, add and foot or hand tamp compact backfill mix at the bottom of the pit or bed to correct the level of over excavation.

b Confirm the depth of each tree pit and if any are over excavated install the Tree Pit Leveling Mound. Backfilling with any other material to correct the excavation depth will not be acceptable.

1) Install the topsoil as the leveling mound as shown on the Drawings and Compact the fill to 85 % density.

4 Plant Positioning: Position as shown on the Drawings. Backfill plant pit to allow setting crown of tree (2) inches above new finish grade and crown of shrub 1 in. above finish grade. Maintain throughout all planting operations.

a Plant Pit or Bed Backfilling

1) Use backfill mix to backfill on-grade plant pits as shown on Drawings. Brace each plant plumb and rigidly in position until the backfill mix has been tamped solidly around the ball and roots.

a) Shrub pits that are underdrained shall have a compacted backfill mix layer installed over the entire shrub bed as shown on the Drawings.

2) When plant pits and plant beds have been backfilled approximately 2/3 full, water thoroughly and saturate rootball or containerized root mass, before installing remainder of the backfill mix to top of pit, eliminating all air pockets. The compaction method shall be the same as described above in the previous item.

a) The Contractor shall exercise particular care to be certain that no backfill mix is placed on top of the rootball or containerized root mass. Also see planting details for incorporation of items noted there.

b) Addition of Slow-Release Fertilizer Tablets: When the plant pits and beds are backfilled to 2/3's of their depth. Locate the number of tablets per plant as recommended below, unless stated otherwise by the approved tablet manufacturer, and place the number of tablets required adjacent to each plant's rootball or container root mass for the specified trees, shrubs, and vines as scheduled below:

Container Stock

1 gallon can - 2 tablets
5 gallon can - 4 tablets

B & B stock:

1 tablet per 1/2 in. caliper or
1 ft. of height, whichever is less

3) Continue backfilling plant pits and beds to their full depth with backfill mix.

4) Watering Basin: Form a circular saucer around each tree, shrub, and vine of backfill mix as shown on the Drawings.

5) All Plants shall be plumb after the backfill mix has been installed.

c Watering: Immediately water all plants after completion of planting operations.

3.08 TREE, SHURB, AND VINE PRUNING

A See Section 31 0125 - Landscape Maintenance.

1 All pruning shall be done at the time of the Preliminary review unless otherwise requested by the Landscape Architect.

3.09 TREE SHRUB AND VINE MULCHING

A Install a layer of mulch over all shrub and annual beds or areas and also all tree and shrub watering basins and beds to the depth(s) and where as shown on the Drawings.

3.10 GROUNDCOVER PLANTING

A Remove groundcover plants from containers and flats. Care shall be taken not to strip the roots from any of the plants.

B Plant groundcover as shown on the Drawings, and cover the roots completely. Do not bury the Groundcover Plant Leaves.

C Watering: Immediately water groundcover areas after planting and correct any settlement of the amended topsoil by removing the affected plants by adding supplemental backfill mix and removing the affected groundcover plants and replanting.

D Ground Cover Bed Mulching

1 Install mulch over the ground cover bed after it has been spaced and planted to the proper planting depth and where and as shown on the Drawings.

a Care shall be taken not to cover any plants or plant leaves with mulch.

E Watering: Immediately water groundcover areas and similarly correct any settled plants.

1 Water as necessary to keep the groundcover in flourishing and healthy condition.

3.11 VINE PLANTING

A Plant vines the same as shrubs and as shown on the drawings.

1 Install fertilizer tablets according to the manufacturer's direction for each vine.

B Water immediately and correct any settlement by removing and replanting the plants after adding additional backfill mix to correct the settlement and replanting the plants to the required height.

1 Water as necessary to keep the vines in flourishing and healthy condition.

C Install mulch to the depth and where shown on drawings.

3.12 PROTECTIVE COVERINGS

1 Install jute mesh as specified in Section 31 2500 – Erosion Control over shrub beds in areas where Meadow Mix is installed.

3.13 MAINTENANCE AND PROTECTION OF NEW PLANTING, AND MATERIALS UNTIL ACCEPTANCE OF THE PRELIMINARY REVIEW

A See Section 31 0125 - Landscape Maintenance.

1 The Maintenance for New Panting shall be as specified in PART-3 EXECUTION of Section 31 0125 for Trees, Shrubs, Groundcovers, Perennials and Annuals.

a This Maintenance shall begin immediately after each plant and or material is installed.

3.14 CLEANUP

A After completion of all work, all debris, rubbish and surplus materials shall be removed from the site. The site shall be left clean to the satisfaction of the Landscape Architect.

END OF SECTION

SECTION 32 9200

LAWNS AND GRASSES

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Provide all labor, materials, equipment, services and transportation required to complete lawns and grasses as shown on the Drawings and as specified herein or both.

B Sustainable Design Intent: Comply with project requirements measured and documented according to the Collaborative for High Performance Schools – Massachusetts (MA-CHPS). Project scores will be verified by a third party certifier.

1 Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Finish Grading - Section 31 2219
2 Earthwork - Section 31 2000
3 Soil Preparation - Section 32 9113
4 Planting - Section 32 9000
5 Landscape Maintenance - Section 31 0125
6 Site Concrete – Section 32 1313

1.04 REFERENCES

A Hortus III - 1976 Edition, Bailey Hortorium, Cornell University.

1.05 SUBMITTALS

A Submit the following in accordance with the provisions of Section 01 3300 – Submittals.

B Product Data:

1 Manufacturer's current catalog cuts and specifications for incorporating mulch and soil stabilizer for hydroseed mix.

2 Grass Seed for Lawn Areas.

3 Wildflower Mix.

4 Jute Mesh.

5 Seeding device for Cultipactor Seeding

B Certificates:

1 Certificates of inspection as required by law for transportation of each shipment of seed along with invoice.

2 Seed mix certificate confirming the grasses and their minimum percent grass seed purity and germination (including incorporated top dress fertilizer and rate of application for hydroseeding and wildflower mix).

C Samples:

1 One pint each of hydroseeding mulch and soil stabilizer.

1.06 DELIVERY, STORAGE, AND HANDLING

A Seed:

1 Delivery: Furnish standard seed in unopened manufacturer's standard containers bearing original certification labels showing quantity, analysis and name of manufacturer.

2 Storage: Protect seed from weather or other conditions that would damage or impair the effectiveness of the product.

B Hydroseeding Mulch:

1 Labeling: Each package of cellulose fiber shall be marked by the manufacturer to show the air-dry weight content.

2 Storage: Protect from weather or other conditions, which would damage or impair the effectiveness of the product.

1.07 CLIMATE RESTRICTIONS

A Do not install lawns during rainy or freezing weather, or when soil is frozen.

B Do not manipulate the planting soils while in an overly wet condition

1.08 TIMING OF INSTALLATION

A Hydroseeded Lawns and Cultipactor Seeding:

1 Hydroseeding shall be done within one (1) calendar days after the completion and acceptance of finish grading in any area.

2 Hydroseeding of Lawns and Wildflower Mix :

Between April 1 - May 31 and
Between August 15 - October 1.

1.09 WARRANTY

A Time Period: Warrant that lawns and grasses shall be in a healthy and flourishing condition of active growth until acceptance by the Landscape Architect of the 90 Day Maintenance Period.

1 Refer to Section 31 0125 Landscape Maintenance Part 3 Execution for lawn maintenance requirements until and during the 90 Day Maintenance Period.

B Appearance During Warranty: Lawns and grasses shall be free of dead or dying patches, disease, and all areas shall show foliage of a normal density, size and color.

1 The flourishing grass coverage for the lawns and grasses shall mean that a minimum of 95% of the area planted shall be covered with the specified grasses by the end of the 90 day maintenance period in order to qualify for the acceptance of the 90 day maintenance period.

C Delays: Delays caused by the Contractor in completing planting operations which extend the planting into more than one planting season shall extend the Warranty Period correspondingly.

D Coverage: Warrant growth and coverage of hydroseeded areas to the effect that the area planted shall be covered with vigorous well established lawn weed free with no bare spots.

E Exceptions: Contractor shall not be held responsible for failures due to damage by Owner, vandalism, or Acts of God during Warranty Period. Report such conditions in writing.

1.10 INSPECTIONS:

A Landscape Architect reserves the right to inspect seed mixes and the hydroseed accessories upon delivery to the site and to reject any or all of the shipment if it does not meet his satisfaction.

1.11 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect’s designated representative.

1.12 MAINTENANCE AND PROTECTION OF NEW LAWNS AND GRASSES AND WILDFLOWERS UNTIL THEIR ACCEPTANCE AT THE PRELIMINARY REVIEW.

A The Contractor's Maintenance of Lawns shall begin as soon as each lawn area is hydroseeded and shall continue until acceptance by the Landscape Architect at the Acceptance of the 90 Day Maintenance Period.

B Maintenance shall begin immediately after the installation of each lawn area.

1 Refer to Section 31 0125 Landscape Maintenance PART 3 -EXECUTION for requirements.

PART 2 – PRODUCTS

2.01 SEED MIXES:

A Seed Mix Uses: Use where shown on the Drawings.

Seed Composition: Use only fresh, clean, certified, new crop seed of the following varieties mixed in the following proportions:

B LAWN SEED MIX TABLE:

1 GRASS SEED MIX FOR HYDROSEEDED LAWNS:

Seeding Rate: 170 lbs/acre or 4 lbs per 1,000 square feet.

SEEDS	SEED MIX PROPORTION MIN. (by weight)	PURITY MIN. (by weight)	GERMIN.
Reliant Hard Fescue	50%	90%	80%
Jamestown II Chewings Fescue	40%	97%	80%
Palmer II Perennial Rye Grass	10%	98%	90%
Total Mix:	100%		

2 WILDFLOWER MIX (Hyroseeded):

a New England Wetlands Plants, newp.com, New England Wildflower Mix.
b Seeding Rate: 23 lbs/acre or 1 lbs per 1,900 square feet.

2.02 SEEDING ACCESSORIES

A Water: Potable water. Transport as required.

B Hydroseeding Mulch:

1 Composition: Green-colored, fibrous, 100% virgin wood fiber mulch containing no growth or germination-inhibiting factors.

2 Weight: Weight specification refers only to air dry weight of the fiber material. Absolute air dry weight is considered equivalent to 10% moisture.

3 Dispersion in Slurry: Mulch shall be manufactured in such manner that after addition to and agitation in slurry tanks with fertilizer, seed, water and other approved additives, fibers in the material will become uniformly suspended to form a homogeneous slurry.

4 Absorption Capacity: When hydraulically sprayed on the ground, the material will form a blotter-like groundcover impregnated uniformly with seed, which will allow the absorption of moisture and allow rainfall to percolate to the underlying soil.

5 Product: "X-100 Spra-mulch" by Pacific Wood Fibers (253) 885-1341, or "Conwed Fiber" by Conwed Corporation (704) 871-8500 or equal.

C Hydroseeding Soil Stabilizer:

1 Composition: Totally organic substance, supplied in powder form and at least 90% of which is 92% pure muciloid derived from ground Plantago ovata-insularis husks. Stabilizer shall be water-soluble, non-toxic hydrophilic and shall not inhibit germination.

2 Product: "Ecology Controls M-binder" by Ecology Controls, (213) 877-8600, "R-Binder" by Clyde Robin Seed Co., (415) 785-0425, or equal.

2.03 HYDROSEEDING EQUIPMENT

A Type: Commercial hydro-seeder with built-in agitation system and an operating capacity sufficient to agitate, suspend and homogeneously mix slurry.

B Distribution Lines: Sufficient to prevent stoppage and provide even distribution of the slurry over the ground.

C Pump Capacity: 150 minimum psi at the nozzle.

D Slurry Tank: 1,000 gallons minimum capacity.

2.04 PROTECTIVE COVERINGS

A Product: Refer to Section 31 2500 – Erosion Control for jute mesh.

PART 3 – EXECUTION

3.01 EXAMINATION FOR LAWN INSTALLATION

A Verification of Conditions:

1 Grades: Verify that grades are within (1) inch plus or minus of the required finished grades. Verify that all soil preparation has been completed and approved. Report all variations in writing.

2 Soil Preparation Work: Verify that all fertilization amending and scarification specified in Section 32 9113 has been completed before any seeding work in Lawn Areas or Wildflower mix Seed Areas shall be done.

3.02 PREPARATION

A The seed bed shall be raked either by power rake or by hand to produce a loose friable seed bed.

B Stones, Weeds, Debris: Verify that all areas to receive lawns grasses are clear of stones larger than (1/2) inch in any dimension, weeds, debris and other extraneous materials shall be removed.

1 Remove and legally dispose any of these materials at no additional cost to the Owner.

C Excessive Soil Moisture: Do not commence work of this Section when soil moisture content is so great that excessive compaction will occur.

D Inadequate Soil Moisture: Apply water, as necessary, to bring soil to an optimum moisture content for planting. Do not work soil when it is so dry that dust will form in air or that clods will not break readily.

E Care shall be taken that no lime, fertilizer, hydroseed mulch or seed mix comes in contact with the adjacent planting areas.

3.03 LAWN AND WILDFLOWER MIX INSTALLATION

A Areas for Lawn Seed are designated and shall be where located on the Drawings and are listed below:

1 Lawn Seed and Wildflower Mix for Hydroseeded Lawns: This mix shall be for hydroseeded lawns and wildflowers.

2 Athletic Field Lawn Seed Mix: These mixes shall be cultipactor seeded only.

B Hydroseeding Preparation: Do all slurry preparation at the job site.

1 Do not dry mix seed or agitation will damage the seed.

2 Blend the water, Lawn Seed mixtures or wildflower mixtures, hydroseeding soil stabilizer and hydroseed mulch into the hydroseeding machine according to the machine's mix schedule and component manufacturer's directions.

3 Commence spraying immediately when the tank is full.

C Hydroseeding Spraying Application:

1 Do not traverse any prepared planting soils with hydroseeding heavy equipment. Wheeled vehicles without low ground pressure tires are expressly prohibited from traversing prepared planting soils

2 General: Apply specified slurry mix in a sweeping motion to form a uniform mat at the specified rate. Keep hydroseeding within designated areas and keep from contact with other plant materials.

3 Unused Mix: Do not use any slurry mixture that has not been applied within four (4) hours of mixing. Promptly remove from the site.

4 Protection: After application, do not operate any equipment over the hydroseeded areas.

5 Reseeding: Reseed all areas and parts of areas that fail to show a uniform stand until all areas comply with the specified Warranty.

D Watering for Hydroseeded Lawns/Wildflowers and Cultipactor seeded Grass Mixes

1 Watering shall be done again within 72 hours of installations or earlier if conditions require.

a Watering shall be done with a fine spray until the seed bed is moistened to a depth of (1/2) inches. Do not use a jet nozzle or permit disturbance of the seed bed or flood adjacent areas.

2 Rejected Materials: Remove rejected materials immediately from the site at Contractor's expense. Pay cost of testing of materials not meeting Specifications.

3.04 PROTECTIVE COVERINGS

1 Install jute mesh as specified in Section 31 2500 – Erosion and Sedimentation Control on slopes 3:1 or greater.

3.05 MAINTENANCE AND PROTECTION OF LAWNS AND ALL GRASS SEED MIXES UNTIL ACCEPTANCE OF THE PRELIMINARY REVIEW

A See Section 31 0125 - Landscape Maintenance.

1 The Maintenance shall be as specified in PART-3 EXECUTION of Section 31 0125 for Lawns.

a This Maintenance shall begin immediately after the material is installed.

3.07 FIELD QUALITY CONTROL

A Tests: Samples of materials may be taken and tested for conformity to Specifications at any time.

3.08 CLEANING

A Erosion: Immediately restore eroded areas. Keep all adjacent paved surfaces cleaned of dirt, mud or stains and organic debris.

B Over - Sprayed Hydroseed Mix: Immediately clean over - sprayed hydroseed mix from any surface other than lawn.

END OF SECTION

SECTION 329400

BIORETENTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 RELATED WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Install all materials specified for the bioretention areas.

B. Related Work: The following items are noted and included in this Section and will be performed under the designated sections:

1. Section 329000 – PLANTING
2. Section 329200 – LAWNS
3. Section 334000 – STORM DRAINAGE UTILITIES

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Testing data for bioretention area soil materials as noted within this specifications and as per testing required within Section 329000-PLANTING and Section 329200 – LAWNS.
2. Testing data for bioretention area materials specified within this section follow the procedure noted.
3. Bioretention Planting Soil infiltration test results.

PART 2 - PRODUCTS

2.1 BIORETENTION MATERIALS

A. The following specifications set forth the required characteristics for materials used in bioretention facilities.

2.2 BIORETENTION SOIL

A. The Bioretention Planting Soil shall be a mixture of sand, compost, and topsoil to the following proportions by volume: 40% Sand, 20-30% topsoil, and 30-40% compost. Compost, sand, and topsoil materials shall be as specified herein.

1. Topsoil: The USDA textural classification of the Topsoil for the Bioretention Planting Soil shall be LOAMY SAND or SANDY LOAM. The Topsoil shall be fertile, friable soil, uncontaminated by salt water, foreign matter, or substances harmful to plant growth. There should be no course fragments over 1-inch in size. The soil shall have at least 4 percent organic matter but not more than 8 percent on a dry weight basis, soil moisture content less than 8% by weight for installation, and a pH range between 5.5 to 6.5. The Topsoil shall be tested and meet the following criteria:

Sieve Size	Percent Passing by Weight
No. 10	85-100
No. 40	35-85
No. 200	10-35
<20µm	< 5

2. The sand component of the Bioretention Soil shall be coarse sand that meets ASTM C-33 (Fine Aggregate) with a Fines Modulus Index of 2.75 or greater and shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

3. The leaf compost shall be a homogeneous and friable mixture of partially decomposed organic matter, with or without soil, resulting from the composting of yard waste in accordance with MassDEP Guidelines. The compost shall not contain biosolids. The compost shall contain less than 1% by dry weight debris including metal, glass, plastic, rubber, asphalt, concrete or masonry. The Carbon to Nitrogen Ratio shall be less than 30 to 1 and the pH shall be between 6.0 and 8.0.

4. The infiltration rate of the Bioretention Planting Soil Layer within the bioretention areas after installation shall be between 4 in/hr and 10 in/hr.

5. The Bioretention Planting Soil shall be a uniform mix, free of plant residue, stones, stumps, roots or other similar objects larger than two inches. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. The Bioretention Planting Soil shall be tested and meet the following criteria:

ITEM	CRITERIA	TEST METHOD
Corrected pH	5.5-6.5	AASHTO D4972
Magnesium	Minimum 32 ppm	*
Phosphorus (Phosphate-P_2O_5)	Not to exceed 69 ppm	*
Potassium (K_2O)	Minimum 78 ppm	*
Soluble Salts	Not to exceed 500 ppm	*

*Use authorized soil test procedures.

a. Should the pH fall outside of the acceptable range, the Bioretention Planting Soil may be modified with lime (to raise) or iron sulfate plus sulfur (to lower). The lime or iron sulfate must be mixed uniformly into the Bioretention Planting Soil prior to use in bioretention facilities.
b. Should the Bioretention Planting Soil not meet the minimum requirement for magnesium, it may be modified with magnesium sulfate. Likewise, should the Bioretention Planting Soil not meet the minimum requirement for potassium, it may be modified with potash. Magnesium sulfate and potash must be mixed uniformly into the Bioretention Planting Soil prior to use in bioretention facilities.
c. Planting soil and/or Bioretention Planting Soil that fails to meet the minimum requirements shall be replaced at no additional cost to Owner. Mixing of the corrective additives to the Bioretention Planting Soil is incidental and shall be at no additional cost to the Owner.
d. Mixing of the Bioretention Planting Soil to a homogeneous consistency shall be done to the satisfaction of the Designer. Upon approval of all requirements and testing above, the Bioretention Planting Soil shall be stockpiled, and no material shall be added to the Bioretention Planting Soil in the stockpile or during transport to the bioretention facility. If the Bioretention Planting Soil stockpiles are not placed in the Bioretention Basins within 30 days from the time of the testing, then the stockpile shall be retested. If the Bioretention Planting Soil no longer meets the requirements indicated above, then the Contractor shall provide the necessary additives to bring the soil back into compliance.

2.3 COARSE SAND

A. The infiltration rate of the Sand Filter layer within the bioretention areas after installation shall be 8 in/hr or greater.

B. The sand filter layer shall consist of clean inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics, surface coatings or other deleterious material. Sand shall meet ASTM C-33 (Fine Aggregate), with a Fines Modulus Index of 2.75 or greater and shall conform to the following gradation:

Sieve Size	Percent Passing by Weight
3/8-inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

2.4 PEA GRAVEL

A. Pea gravel shall be placed over the underdrain crushed stone. Pea gravel shall consist of durable crushed rock or durable crushed gravel stone free from ice and snow, sand, clay, loam, or other deleterious or organic material. The peas gravel shall be double washed and shall be ¼ to 3/8 inch in size or equivalent to #9 double washed crushed stone.

2.5 CRUSHED STONE

A. The crushed stone to be placed around the underdrain piping shall be clean double-washed crushed aggregate, free of rock dust, fines or soil particles. Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements:

Sieve Size	Percent Passing by Weight
1-inch	100
¾-inch	90-100
½-inch	10-50
3/8-inch	0-20
No. 4	0-5

2.6 UNDERDRAIN PIPING

A. Underdrain piping shall be used in the drainage stone layer of the bioretention facilities as indicated on the plans.

B. Clean out pipes must be provided where indicated on the plans.

C. Underdrain piping shall conform to the following specifications:

PIPE	STANDARD	PERFORATIONS
4" Corrugated Polyethylene Pipe	AASHTO M252, Type S	0.875" X 0.125" slots located in the outside valleys of the corrugations
4" Schedule 40 PVC	ASTM D-2665	5/8" holes @ 5" on center, located at the 4- and 8-o'clock position of the installed pipe

2.7 DRAINAGE FABRIC GEOTEXTILE FOR TEMPORARY SOIL PROTECTION

A. Filter fabric shall be used to temporarily cover the installed bioretention material layers to prevent siltation from other construction until the next material layer is placed. The fabric is to be removed prior to the placement of the next material.

B. Drainage filter fabric shall meet the following Minimum Average Roll Value (MARV) specifications across the weave:

PROPERTY	TEST METHOD	REQUIREMENT	PROPERTY	TEST METHOD	REQUIREMENT
Grab Tensile Strength	ASTM D-4632	80 lb. min.	Puncture Strength	ASTM D-4833	45 lb. min.
Grab Tensile Elongation	ASTM D-4632	50% max.	UV Resistance	ASTM D-4335	70% at 500 hrs min.
Trapezoidal Tear Strength	ASTM D-4533	35 lb. min.	Apparent opening	ASTM-D-4751	40-80 US Sieve
Mullen Burst Strength	ASTM D-3786	160 psi. min.	Permeability	ASTM D-4491	110 gal/min/ft.2 min.

2.8 IMPERMEABLE GEOMEMBRANE LINER

A. If basin excavation exposes subgrade determined by the Engineer or Soil Scientist to be at risk of instability due to hydrostatic subsurface water pressures from full bioretention basin, an impermeable geomembrane layer shall be required.

B. Geomembrane liner shall be a minimum of a 40-mil linear low-density polyethylene or thicker material, such as RUFCO 4000B or an approved equal, conforming to ASTM D 1593.

PART 3 - EXECUTION

3.1 COORDINATION

A. *Pre-Installation Examination Required:* The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify the Owner in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means the Contractor accepts substrates, previous work, and conditions. The Contractor shall not place any planting soil until all work in adjacent areas is complete and approved by the Owner.

B. The Engineer or Soil Scientist shall review the subgrade for conditions that warrant the installation of the impervious membrane.

C. Coordinate activities with other project contractors so that there is no soil disturbance from traffic or other construction activities subsequent to placement.

D. Excavate and install underdrainage system during construction of the Planting Soil underdrainage to facilitate ease of subsurface connections. Protect gravel and underdrainage perforated piping from construction sediment by temporarily covering gravel/piping with filter fabric.

E. Schedule and coordinate bioretention basin soil installation with placement of Planting Soils in adjacent areas.

F. Restrict all additional traffic other than installation from retention areas prior, during, and after installation.

3.2 EXCAVATION AND COMPACTION

A. Compaction of the bioretention areas shall be avoided prior to construction. Place barricades to restrict access to the areas.

B. Do not work the soil when it is too moist or frozen. If the soil smears when worked, it is too moist. Refer to Section 329000-Planting and Section 329200 – Turf and Grasses.

C. The subgrade shall be nearly level with a gradient less than ½ (0.5) percent.

D. Subsoil compaction at the base of the bioretention facility shall be alleviated using primary tilling equipment such as a chisel plow, ripper, or subsoiler. Tilling operations shall be used to refracture the sub-grade to a depth of 12 inches.

3.3 BIORETENTION CONSTRUCTION

A. Crushed Stone Installation: After excavation of the basin bed is complete and preparation of the subgrade meets specifications, install at least 4 inches of the specified crushed stone gravel in the bottom of the retention basin prior to pipe placement.

B. Perforated Pipe Installation:

1. The main collector pipe for underdrain systems shall be constructed with a slope between 0.25 to 1.0%. All piping shall be of uniform gradient and provide unrestricted flow to the outlet.
2. Perforated pipe shall be placed with the perforations down at 4 and 8 o’clock positions (PVC pipe).
3. The ends of underdrain pipes without a cleanout shall be capped.
4. Place the remaining specified crushed stone to a depth of 12 inches.

5. Temporarily cover the crushed stone surface with fabric to prevent sedimentation of the gravel layer prior to the placement of the pea gravel layer. The fabric is to be removed prior to pea gravel layer placement.

C. Pea Gravel Installation: Place the pea gravel to a depth of 4 inches.

D. Sand and Bioretention Planting Soil Installation: Never work bioretention planting soil when wet or frozen. See Section 329000-Planting and Section 329200 – Turf and Grasses for coordination procedures.

1. The Bioretention Planting Soil media shall be homogenous. Soils that have visible lumps of material or coarse fragments (rocks) greater than 2.5 cm (1-inch) is cause for rejection.
2. The sand and bioretention planting soil shall be placed in 6-inch lifts. Installation traffic is allowed to spread and "seat" the soil, but additional soil compaction is strictly forbidden. Do not use heavy equipment within the bioretention facility.
3. Scarify the surface of each lift to prevent compaction interfaces that will reduce the functionality of the retention basin.
4. Test infiltration rates of completed Sand Filter layer and submit results to the engineer. Determine permeability of the layer using a single ring infiltrometer method after it has been scarified. Gain approval of Sand Filter layer installation infiltration prior to placement of the Bioretention Planting Soil layer. At the completion of the Bioretention Planting Soil layer prior to plant and seed placement, test the infiltration rate and submit to the engineer.
5. Heavy equipment can deliver bioretention materials to the basin from outside of the bioretention area.
6. Grade bioretention materials with light equipment such as a tracked skid-steer or a dozer/loader with marsh tracks.
7. Back blading of the soil with buckets or doze blades is strictly forbidden.
8. The bioretention planting soil media shall be saturated with water to settle the media before the final lift so that it can be adjusted in the field to correspond to the plan elevations. The water to saturate the placed bioretention planting soil shall either be provided by the Contractor or from a rain event capable of saturating the soil.
9. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plan growth, or prove a hindrance to the planting or maintenance operations.

3.4 PROTECTION AND REPAIRS

A. During bioretention area construction, protect partially finished soil installation with weighted plastic tarps during heavy precipitation events until protective vegetation has been placed and established.

B. Place soil erosion structures such as filter fence, straw bales, and erosion netting on the surfaces of bare soil surrounding the bioretention basins until vegetation is established.

C. If blowing of material is a concern, a biodegradable netting can be spread over the surface until the facility has gone through several wetting cycles.

D. Bioretetion Area Protections shall be maintained until the surrounding surface areas throughout the entire vegetation establishment period and as approved by the Engineer.

E. Vegetate the surrounding catchment areas as quickly as possible.

F. Protect newly graded areas from traffic, freezing and erosion. Keep free of trash, debris or construction materials.

G. Repair, re-shape and re-establish finished grades where areas settle, erode, are disturbed or damaged.

H. Refer to Section 329000-Planting and Section 329200 – Turf and Grasses for coordination of protection measures between retention construction and planting soil installation.

3.5 INSPECTION AND MAINTENANCE

A. After construction, monthly inspection of the bioretention facilities shall be conducted until the plants are established.

B. The Contractor shall provide water to establish the seeding and/or plantings within the bioretention area.

C. Remove all visible accumulations of sediment on top of the vegetated surface with a flat shovel. Stabilize eroded areas with appropriate geotextile and replant as required to establish growth.

END OF SECTION

SECTION 33 10 00
WATER UTILITIES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Installation of ductile iron pipe, fittings, accessories, and appurtenant work, at the locations and to the lines and grades indicated on the Contract Drawings.
2. The installation of hydrants, gate valves and boxes and concrete thrust blocks.
3. Furnishing and installation of all materials required to connect to existing water mains, replace existing services, new gate valves, tapping sleeves, removal of existing gate valves, corporation cocks, saddles, curb stops, service boxes, and abandoning of the existing water system (if applicable), all as shown on the Contract Drawings. All valves, twelve (12) inches and larger shall be butterfly valves. All abandoned pipes shall be plugged and capped with concrete.
4. In accordance with 528 CMR 12.00, work on the fire protection system, including hydrants and exterior underground piping, shall be performed by a Licensed Fire Protection Sprinkler Systems Contractor. The fire protection exterior underground piping will terminate at the valved tee connection to the water distribution system. The tee and valve will not be considered part of the fire protection system work.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections.

1. Section 31 20 00 – EARTH MOVING for excavation, backfill, and compaction requirements.

2. Section 21 11 00 – FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

1. Descriptive literature showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
2. Product Data: Submit manufacturer's technical product data and installation instructions for potable water system materials and products.
3. Shop Drawings: The Contractor shall submit for review shop drawings or descriptive literature for potable water system, showing piping, fittings, couplings, valve, hydrants, materials, dimensions, restrained joint calculations, joints and other details, blocks, and anchors. All hydrants and valves furnished under the Contract shall be manufactured

only in accordance with the Specifications and the approved Shop Drawings.

4. Record Drawings: At project closeout, submit record drawings of installed potable water system piping and products, in accordance with requirements of Division 1. As-Built Drawings shall be complete and shall indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built Drawings shall include a minimum of three (3) ties to each valve cover from fixed permanent objects. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor and Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing file (release 2002 or higher).
5. Maintenance Data: Submit maintenance data and parts lists for water system materials and products. Include this data, product data, shop drawings, and record drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. ASTM: American Society for Testing and Materials.
2. ANSI: American National Standards Institute.
3. AWWA: American Water Works Association.
4. AASHTO: American Association of State Highway and Transportation Officials.
5. Commonwealth of Massachusetts, Massachusetts Highway Department (MHD), Standard Specifications for Highways and Bridges, latest English Edition with amendments, hereinafter referred to as the “Standard Specifications.” All references to method of measurement, basis of payment and payment items in the Standard Specifications are hereby deleted. References made to particular sections or paragraphs in the Standard Specifications shall include all related articles mentioned therein.
6. Commonwealth of Massachusetts, Massachusetts Highway Department, Construction Standards, latest Edition with amendments, hereinafter referred to as the “Construction Standards.”
7. Commonwealth of Massachusetts State Plumbing Code, latest edition.
8. Commonwealth of Massachusetts Regulations 528 CMR 12.00 Sprinkler Contractor Licensing Regulations.
9. Town/City Water Department Regulations

1.5 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of portable water systems materials and products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

B. Installer's Qualifications: Firm with at least three years of successful installation experience on projects with portable water piping work similar to that required for this project.

C. Water Purveyor Compliance: Comply with requirements of Purveyor supplying water to project, obtain required permits and inspections.

D. A Certificate of Substantial Completion shall be issued upon acceptance of this work.

PART 2 – PRODUCTS

3.1 DUCTILE IRON PIPE AND FITTINGS

A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Engineer to comply with installation requirement. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

1. Ductile iron pipe shall be that of a manufacturer who can demonstrate at least five years of successful experience in manufacturing ductile iron pipe. The pipe shall be equipped with push-on type, restrained joint, or mechanical joints, as required.
2. All ductile iron water pipe shall conform to American Water Works Association (AWWA) C150 and AWWA C151.
3. The ductile iron pipe shall be Class 52 and furnished in minimum nominal 18-foot lengths, with Push-on or Mechanical Joints as manufactured by U.S. Pipe and Foundry Company, Atlantic States Cast Iron Pipe Co., Clow Corporation, or approved equal with gaskets conforming to AWWA C111 "Rubber Gasket Joints". A minimum of two brass wedges per joint shall be used to maintain conductivity and facilitate lock-on.
4. All ductile iron pipes shall be rated for a minimum operating pressure of 350 psi.
5. The ductile iron water pipe shall be double cement lined inside and then asphalt seal coated in accordance with AWWA C104 and AWWA 203. The pipe shall be furnished along with necessary materials and equipment recommended by the manufacturer for use in joining pipe lengths and fittings.
6. All water pipe shall be encased in polyethylene film when the trench is backfilled with control density fill.
7. Fittings shall be short body ductile iron Class 350 Mechanical Joint, conforming to ANSI Specification AWWA C153, latest edition, for pipe sizes 16-inches and smaller, and Class 350 standard Mechanical Joint fittings conforming to AWWA C110, latest edition, for pipe sizes 16 through 24-inches, unless specifically stated otherwise in the Specifications or on the Contract Drawings. Fittings shall have the same lining and coating as the pipe specified above. All fittings shall be marked with the weight and shall have distinctly cast upon them the pressure rating, the manufacturer's identification, nominal diameter of openings and the number of degrees or fraction of the circle on all bends. Fittings greater than 24-inches shall be as specified above except they shall be Class 250. All nuts and bolts shall be of a type equal to ductile iron or KOR-10 steel T-bolts and nuts or an approved equal.
8. In order to provide positive joint restraint, valve anchor tees/valves and restrained joints shall be used on fires services and the on 6-inch branch connections for hydrants.
9. Caps and plugs installed in all new work as indicated on the Contract Drawings shall be provided with a threaded corporation or bleeder valve so that air and water pressure can be relieved prior to future connection.
10. Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross-connections, whether or not specifically stated in the Contract Drawings and Specifications.
11. All pipe shall be marked with the class, thickness designation and initials of the manufacturer.
12. If required the manufacturer shall supply the Engineer with certificates of compliance with these Specifications and certification that each piece of ductile iron pipe has been tested at the foundry with the Ball Impression Test, Ring Bending, or equal.
13. Thrust blocks shall be used at all bends and fittings as shown on the details. In addition, all bends and fittings shall be restrained with Megalug Series 1100 mechanical joint restrained. In the event that the use of thrust blocks is not practical, the Contractor shall

provide an alternate method of joint restraint, at no additional cost to the owner, as approved and/or as directed by the Engineer. Restraint length calculations and restrained joint locations shall be provided by the contractor and submitted to the engineer for review. Restraint length values shall be calculated per the manufacture's standards.

a. Restraint for standardized mechanical joints shall be incorporated in the design of the follower gland and shall impart multiple wedging action against the pipe, increasing its resistance as the pressure increases. The assembled joint shall maintain its flexibility after burial and shall maintain its integrity by a controlled and limited expansion of each joint during the wedging action. Restraining glands shall be manufactured of high strength ductile iron conforming to the requirements of ASTM A536, Grade 65-45-12. Wedging mechanisms shall be manufactured of ductile iron, heat treated to a hardness of 370 BHN minimum. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of ANSI/AWWA A21.11/C111 and ANSI/AWWA A21.53/C153 of latest revision. Twist-off nuts shall be incorporated in the design of the wedge activation screws to insure proper torque. The mechanical joint restraining device shall have a water working pressure rating of 350 psi minimum (in sizes 4" thru 16") with a safety factor of at least 2:1 against separation when tested in a dead-end situation.
b. Restraint for push-on ductile iron pipe shall consist of a wedge action restraint ring on the spigot joined to a split ductile iron ring behind the bell. The restraint ring shall have individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The restraint ring and its wedging components shall be made of minimum grade 65-45-12 ductile iron conforming to ASTM A536. The wedges shall be heat treated to a minimum hardness of 370 BHN. Torque limiting twist off nuts shall be used to insure proper actuation of the restraining wedges. The split ring shall be made of a minimum grade of 65-45-12 ductile iron conforming to ASTM A536. The connecting tie rods that join the two rings shall be made of low alloy steel that conforms to ANSI/AWWA C111/A21.11. The assembly shall have a rated pressure with a minimum two to one safety factor of 350 PSI in the sixteen inch size and below 250 PSI in the eighteen through thirty-six inch sizes. Push on joints on ductile iron pipe shall be restrained with Megalug Series 1700 restraint harness.

14. Insulation shall be manufactured by Thermal Pipe Systems, Atlas Insulation, or Insulated Piping Systems Inc., or other approved manufacturer. Insulation shall be factory foamed-in-place polyurethane foam insulation having nominal thickness of 1 1/2-inch, with an in-place density of 2.5 pcf, and a "K" factor of 0.14 BTU/in./hr./°F/sq. ft. Straight joints between insulated pipe lengths, and the end sections of non-insulated pipe, shall be sealed with heat shrinkable wrap-around polyethylene as supplied by manufacturer and installed in field by Contractor. Insulation jacket shall be 20 gauge corrugated aluminum preformed to be fastened with stainless steel screws and bands. Jacket shall have one layer of one mil polyethylene film with a protective coat of 40 pound virgin Kraft paper to act as a moisture and galvanic corrosion barrier.
15. Pipe for use with split couplings shall be as specified except that the ends shall not have bells or beads but shall have cast or machined shoulders or grooves as necessary for the couplings to be used and shall conform to the specifications of the manufacturer of the couplings. If split couplings are used with grooved ductile-iron pipe, the minimum pipe wall thickness shall be as follows:

Nominal Pipe Size (In.) Thickness Class

14-18	54
20	55
24	56

16. Pipe for use with sleeve-type couplings shall be as specified except that the ends shall be plain (without bells or beads). The ends shall be cast or machined at right angles to the axis.

B. COUPLINGS AND ADAPTERS FOR DUCTILE IRON PIPE

1. Sleeve-type couplings for plain-end pipe shall be provided with plain rubber gaskets and steel, tee-head bolts with nuts. Couplings shall be Dresser style 38 or 138, furnished preassembled, as manufactured by Dresser Industries, Inc., Smith-Blair, Coupling Systems, Inc., or equal.
2. Couplings or adapters as required for connecting existing pipe to new pipe or new pipe to new pipe shall be furnished as required and designed for compatibility with the pipe and operating pressures encountered. Couplings shall be Dresser Style 162 as manufactured by Dresser Industries Inc., or equal. Flanged adapters shall be Dresser Style 128, or equal. Couplings for ductile iron to cast iron pipe shall be Style 53, and for ductile iron to transite pipe shall be style 153, as manufactured by Dresser Industries, Inc., or as manufactured by Smith-Blair, Coupling Systems, Inc. or equal. Transition couplings shall be style 162 as manufactured by Dresser Industries, Inc. or approved equal.
3. Split couplings may be used for connecting gray cast iron or ductile iron. If split couplings are used with grooved ductile iron pipe, the minimum pipe wall thickness shall be as specified. Split couplings shall be made of malleable iron and shall be suitable for use with grooved-end or shouldered-end, cast iron pipe. They shall be Victaulic couplings made by the Victaulic Company of America, Elizabeth, New Jersey; Gruvagrip couplings made by Gustin-Bacon Manufacturing Company, Kansas City, Missouri; Groove couplings made by Eastern Malleable Iron Company, Pittsburgh, Pennsylvania; or equal products.
4. Flexible Couplings: Sleeve-type couplings for plain-end ductile iron pipe shall be provided with plain rubber gaskets and steel, track-head bolts with nuts.
5. Couplings shall be furnished pre-assembled by the manufacturer.
6. Couplings shall be given a shop coat compatible with the same outside coating as the pipe specified above.
7. All couplings shall be furnished with the pipe stop removed.
8. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe. The gaskets shall have metallic tips to provide electrical continuity through the joint.
9. The Contractor shall provide suitable filling rings where the layout of the flanged piping is such as to necessitate their use. In materials, workmanship, facing, and drilling, such rings shall conform to the 125 pound ANSI Standard. Filling rings shall be of suitable length with nonparallel faces and corresponding drilling, if necessary, to endure correct assembly of the adjoining piping or equipment.
10. Couplings for exposed pipe shall be of steel and shall be Dresser Style 38, Smith-Blair Style 411, Baker Allsteel, or equal. The couplings shall be provided with steel bolts and nuts.
11. At the Contractor's option, flexible connections in the piping shall be sleeve-type couplings, split couplings or mechanical joint pipe as herein specified.

C. INSPECTION, TESTS AND ACCEPTANCE FOR DUCTILE IRON PIPE

1. All pipe delivered to the job site shall be accompanied by test reports certifying that the pipe and fittings conform to "AWWA Standard for Ductile Iron Pipe, for Water and Other Liquids" (AWWA H3) and (AWWA C151).
2. All tests shall be made in accordance with the methods prescribed by the above mentioned AWWA Standards, and the acceptance or rejection shall be based on the test results.
3. Pipe which does not conform to the requirements of this contract shall be immediately removed and replaced by the Contractor.
4. All ductile iron pipe to be installed under this Contract may be inspected at the foundry for compliance with these Specifications by an independent testing laboratory selected by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of the inspection of a reasonable amount of disapproved pipe, will be borne by the Owner.

D. FLANGED JOINTS FOR DUCTILE IRON PIPE

1. For flanged joints, gaskets shall be ring gaskets of rubber with cloth insertion. Gaskets twelve (12)-inches in diameter and smaller shall be 1/16-inch thick, gaskets larger than twelve (12)-inch shall be 3/32-inch thick.
2. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges. Bolts and nuts shall, except as otherwise specified or noted on the Contract Drawings, be Grade B conforming to the ASTM Standard Specification for Carbon Steel, Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts and studs shall be of the same quality as machine bolts. Flanged ductile iron pipe from 3 to 48-inches in diameter shall be classified by Underwriters Laboratories Inc. in accordance with AWWA C115.

3.2 PVC WATER PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

B. PVC pipe used for water mains shall be polyvinyl chloride (PVC) pipe, Class 150 with integral thickened wall bells, as manufactured by Manville Corporation, Certain-Teed Corporation, Capco or approved equal. Pipe shall be made from clean, virgin approved Class 12454-B PVC compound conforming to AWWA specification C900.

C. All pipe shall meet with cast iron pipe equivalent outside diameters.

D. All pipe and fittings shall be marked with size, class, material, grade and initials of the manufacturer. The pipe shall be furnished in standard 20-foot lengths.

E. All pipes shall be suitable for use as a pressure conduit for potable water.

F. Each pipe length shall be hydrostatic proof-tested to four times the class pressure of the pipe for a minimum of five seconds.

G. The pipe shall withstand without failure an impact of 100 ft/lb for pipe sizes 8-inches and smaller from a freely falling missile; with a 2-inch radius nose at 70°F., as per ASTM D2444. There shall be no visible evidence of shattering, cracking or splitting when energy is imposed.

H. Randomly selected samples shall be quick burst tested in accordance with ASTM D1599. The pipe shall withstand without failure a pressure of 755 psi applied in 60 to 70 seconds at 73°F.

I. The pipe shall not balloon, burst or weep as defined in ASTM D1598 when tested at a sustained pressure of 500 psi applied for 1,000 hours as specified in ASTM D2241.

J. The inside surface of each length of pipe shall be free from nicks, scratches and other surface defects and blemishes. The pipe shall be homogenous throughout free of any bubbles, voids or inclusions.

K. If requested, the manufacturer shall supply the Engineer with certificates of compliance with specifications and certifications that each piece of PVC pipe conforms to AWWA Specification C900 and has been tested with the Drop Impact Test in accordance with ASTM D2444.

L. The integral socket bell of the PVC pipe shall meet the same strength requirements as that of the pipe. The bell shall have grooves into which an elastomeric gasket with solid cross section is inserted. This joint shall conform to the requirements of ASTM D3139 and shall provide for expansion and contraction of the pipe.

M. Removable elastomeric gaskets for PVC pipe and fittings shall meet the requirements of ASTM F477 and shall be capable of withstanding pH's as high as 9.5. The elastomeric gasket shall provide a tight seal that protects the line from shock and vibration, and compensates for expansion and contraction of pipe lengths. The elastomeric gasket shall not support the growth of bacteria.

N. Lubricant used for joint assembly shall be non-toxic, shall not support the growth of bacteria and shall have no deteriorating affect on the gasket material.

O. Restrained joints shall be furnished for installation where shown on the Contract Drawings. Restraints for mechanical joint fittings shall be Series 1100 PV Megalug as manufactured by EBAA Iron Sales Co. or approved equal. Restraints for push-on joints shall be Series 2000PV as manufactured by EBAA Iron Sales Co. or approved equal.

3.3 BUTTERFLY VALVES

A. Butterfly valves shall be cast iron ASTM A-126 Class B body and shall have integrally cast mechanical joint ends, and Type 304 stainless steel body seat made integral with the valve body. Valves and components shall meet all requirements of AWWA C504.

B. Valve vane shall be constructed of high strength cast iron ASTM A48 Class 40.

C. Valve shafts for sizes up to and including 12-inch shall be one piece stainless steel extending full size through the disc and bearings. Valve shafts for 14-inch and larger shall be 18-8 stainless steel stub shaft design keyed to the vane with stainless steel taper pins.

D. Valve seats shall be Buna N vulcanized mechanically secured to the vane with an integral stainless steel seat-retaining ring and self-locking Series 300 stainless steel screw fasteners. Valve seats located in the body on the valve shall be retained be mechanical means without rings, screws, etc. All seats shall provide full 360-coverage and be field adjustable and replaceable.

E. Valve bearings shall be sleeve type, corrosion resistant, and self-lubricating with load not to exceed 2,500 pounds per square inch.

F. Valve operator shall be traveling nut type suited for buried service. Operator shall produce required operating torque to seat, unseat or hold the vane steady in any intermediate position.

Operator shall produce required operating torque with a maximum input of 150 ft-lbs. on the wrench nut. All actuator components between input and stops shall withstand without damage an input torque of 300 ft-lbs. minimum. It must be fully gasketed and grease packed and designed to withstand submersion in water to 10 pounds per square inch. Valves shall have 2-inch standard AWWA operating nuts. All valves shall open per the Town of Concord Water Department Standards.

G. Valves shall have hydrostatic and leakage tests conducted in accordance with AWWA C504. Valves 12-inch and less shall be tested bubble-tight at a rated working pressure of 200 psi. Valves 14-inch and larger shall have a rated working pressure of 150 psi.

H. Butterfly valves shall be as manufactured by M & H Valve Company, Dresser, Clow, or approved equal.

3.4 RESILIENT WEDGE GATE VALVES

A. Resilient wedge gate valves shall be iron body, resilient seated type. The valves shall be designed for 250 psi working pressure and 400 psi test pressure.

B. Valves are to have O-ring seals and a nonrising stem. Valves shall have a 2-inch operating nut. Valves shall open per the Town of Concord Water Department Standards.

C. Resilient gate valves shall meet the most recent version of the AWWA standard specification AWWA C509.

D. Resilient wedge valves shall have mechanical joint ends.

E. Valves shall be as manufactured by U.S. Pipe and Foundry Company Metroseal 250 or American Flow Control Model AFC2500.

F. Valve boxes shall be cast iron, asphalt coated, sliding, heavy pattern type, consisting of three (3) pieces; a flanged bottom piece, a flanged top piece, and a cover with two (2) lifting holes and the word "water" cast on the top. A minimum 6-inch overlap is required between sliding sections. The valve box shall be designed and constructed to prevent direct transmission of traffic loads to the pipe or valve. The inside diameter of boxes shall be at least 4 1/2-inches and lengths shall be as necessary to suit ground elevation. The top of the cover shall be flush with the top of the box rim. Box covers shall be round frame and cover.

G. Valves shall be connected directly to valve anchor tees at all hydrant branches.

3.5 TAPPING SLEEVES AND VALVES

A. Tapping sleeves shall be of ductile iron construction, meeting ASTM A536 Grade 65-45-12. Side flange seals shall be O-Ring type of round, oval or rectangular cross-section shape. Sizes 12” and smaller must be capable of working on Class ABCD pipe diameters without changing either half of sleeve. Sizes 14” and larger must be specified to which class is needed. All sleeves are to include the end joint accessories and split glands necessary to assemble sleeve to pipe. Sleeve shall be coated with asphaltic varnish in compliance with NSF-61.

B. Tapping valves shall conform to the requirements specified above for gate valves except that all Tapping sleeves and valves shall consist of a ductile iron flanged by mechanical joint sleeves and a tapping-type gate valve with one flange and one mechanical joint end. The valve shall conform to the requirements herein before specified for gate valves. The Contractor shall be responsible for verifying the outside diameter of the pipe to be tapped.

C. The valve shall be provided with an oversized seat to permit the use of full size cutters. Before backfilling, all exposed portions of any bolts used to hold the two halves of the sleeves together shall be heavily coated with two coats of bituminous paint comparable to Inertol No. 66 Special Heavy. Sleeves shall be of ductile iron furnished with O-ring gaskets.

D. Bolts on bonnet and stuffing box shall be stainless steel (316 stainless steel), stuffing boxes shall be "O" ring type as indicated. Gaskets shall cover the entire flange surface.

E. The valve shall be provided with an oversized seat to permit the use of full size cutters. Before backfilling, all exposed portions of any bolts used to hold the two halves of the sleeves together shall be heavily coated with two coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

3.6 POST INDICATOR VALVE

A. Post indicating valve assembly shall consist of a buried butterfly valve and above-grade indicator actuator of the traveling nut type with a tamper-proof switch.

B. Posts shall have two large window openings that shall be fitted with a heavy clear Plexiglas. Aluminum target plates, with large words OPEN and SHUT cast in large, easy-to-read, raised letters shall be located directly behind each window in such a position that the appropriate words appears as the valve is opened.

C. The target mechanism shall consist of an internal rotating member that contains a 2¾-inch hole on four sides.

D. The outer member is stationary and shall contain similar holes.

E. A fail-safe spring shall be included on the post to preclude accidental closing.

F. Stem, indicators, and all working parts shall be fully protected from moisture and weather damage.

G. The butterfly valve and post assembly shall be Underwriters Laboratory listed and Factory Mutual approved.

H. Valves shall be manufactured in accordance with AWWA C504, Class 150B.

3.7 HYDRANTS

A. General: Provide Hydrants as indicated. The Hydrants shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the hydrant.

1. Fire hydrants shall meet or exceed AWWA C-502, latest revision and shall comply with Factory Mutual Research Corporation and Underwriters' Laboratories UL 246 Standard. Rated water working pressure shall be 200 psi, test pressure shall be 400 psi.
2. The main valve closure shall be of the compression type, opening against the pressure and closing with the pressure.
3. Hydrants shall be of the breakaway type: The upper barrel shall connect to the lower barrel with a breakable traffic flange and 8 bolts and nuts. This connection shall allow 360 degree rotation of the upper nozzle section.
4. The main valve opening shall be 5-1/4 inch and be designed so that removal of seat, drain valve mechanism, internal rod and all working parts can be removed through top of

hydrant. These parts shall be removable without disturbing the ground line joint or the nozzle section of the hydrant. The bronze seat shall be threaded into mating threads of bronze for easy field removal.

5. The draining system of the hydrant shall be bronze and activated by the main stem without use of auxiliary rod, toggles, pins, etc. The drain mechanism shall be completely closed after no more than three turns of the operating nut in the opening direction. There should be a minimum of (2) inside ports and (4) drain port outlets to the exterior of the hydrant. Drain shut off to be by direct compression closure.
6. The operating nut, main stem, coupling and main valve assembly shall be capable of withstanding input torque of 200 ft. lbs in opening or closing directions. There shall be an internal top housing with triple O-Rings to seal operating threads from the waterway and accommodate an anti-friction washer.
7. Fire hydrants shall have 6-inch mechanical joint inlet connections to the main, two 2 1/2-inch hose connections, 180-degrees apart, and one 4 1/2-inch steamer connection. The hose and steamer connections shall have National Standard Thread. The standpipe shall have an 8 1/2-inch minimum diameter. All nozzle caps shall be cast iron and shall be secured to the hydrant barrel with chains.
8. Hydrant shall be marked with an arrow and the word "open" to indicate the direction to turn the stem to open the hydrant. Hydrants shall open to the per the Town of Concord Water Department Standards, and have a bronze operating nut that shall be pentagonal in shape, 1-1/2 inch from point to opposite flat.
9. The upper barrel shall be ductile iron with markings identifying size, model and year of manufacture. The lower barrel shall be ductile iron.
10. The hydrant shall have a minimum working pressure of 200 psi. Hydrant design shall be of positive automatic drain type to prevent freezing.
11. Hydrants shall be thoroughly cleaned and given two (2) shop or field coats of paint in accordance with AWWA C502 and the instruction of the paint manufacturer. Paint color shall be the standard hydrant color of the Town of Concord.
12. If the hydrant is delivered with the manufacturer's standard color, the hydrant shall be given one (1) matching field coat of alkyd gloss enamel. If the hydrant is delivered with no standard color, the hydrant shall be given two (2) coats of alkyd gloss enamel according to the colors specified by the Town of Concord.
13. All expose metal surfaces will be painted.
14. Hydrant paint shall be as manufactured by Sherman-Williams, PPG Industries, Pittsburgh, PA; Koppers Company, Inc., Pittsburgh, PA ; Tnemec Company, Inc. Kansas City, MO; or approved equal.
15. Alkyd gloss enamel shall be Series 54-300 by PPG; Glamortex by Koppers; 2H-Tneme by Tnemec or approved equal.
16. Hydrants shall be American Darling (American Flow Control) Model B-62 B, Mueller Centurion, Kennedy Guardian, U. S. Pipe Metropolitan, Waterous WB-67 or others as acceptable to the jurisdictional authority.

B. HYDRANT SAFETY FLANGE REPAIR KITS

1. Safety flange repair kits shall come complete with stem coupling, safety flange, flange gasket, replacement bolts and nuts and hydrant lubricating oil.
2. Safety flange repair kits shall be compatible with hydrant furnished.

C. HYDRANT EXTENSION KITS

1. Extension kits shall come complete with extension barrel, extension stem, stem coupling and hardware, flange, flange gasket, 8 bolts and nuts and hydrant lubricating oil.
2. Extension kits shall be compatible with hydrant furnished.

3.8 SIAMESE CONNECTION (if required)

A. Siamese shall be a “two way” Siamese 4 x 2-1/2 x 2-1/2. Shall be installed with pin lug caps and chains, sleeves, escutcheon plate, and shall be polished chrome. Piping from Siamese connection into the building shall be restrained joint ductile iron.

3.9 SERVICE TUBING, CORPORATIONS, STOPS, SADDLES, AND VALVE BOXES

A. Tubing for water supply to water fountain as shown on the Contract Drawings shall meet the requirements of Federal Specification WW-T 7996 and shall conform to ASTM specification B75, B68 and B88 as they apply to Type K Copper Tubing.

B. Copper Tube Size (CTS) Polyethylene Tubing for domestic water uses shall conform to AWWA C901, ASTM D3350, and ASTM D2737 and shall have a working pressure rating of 200 psi. Tracer wire shall be attached to the tubing and connected to upstream piping of the associated water meter for the water service, as applicable.

C. The Contractor shall furnish and install, including necessary taps and connections, corporation stops, CTS Polyethylene Tubing, curb stops and wastes.

D. The corporation stops shall meet the most recent revision of the AWWA standard "Threads for Underground Service Line Fittings." (AWWA C800).

E. Corporation stops shall be sized as shown on the drawings and be brass compression-type with CC thread (Mueller Brand with compression nut with set screw). Corporation stops shall open left.

F. Curb Stops: Curb stops shall be sized as shown on the drawings and be brass compression-type with drain (Mueller Brand with compression nut with set screw). Curb stops shall open left.

G. Tapping Saddles: Service connections shall be tapped with Size 2” X 8” double strap service saddles.

H. Fittings and Boxes: Service boxes shall be cast iron. Extension service boxes of the required length and having slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the curb stop and shall be complete with identifying covers

I. Service boxes shall be 2 ½” Buffalo Style, heavy cast iron, tar coated, sliding type, consisting of three (3) pieces; a flanged bottom piece, a flanged top piece and bolted cover with the word "water" cast on the top. A minimum 6-inch overlap is required between sliding sections. The boxes lengths shall be as necessary to suit ground elevation.

3.10 FROSTPROOF PEDESTAL FOUNTAIN (if required)

A. Frostproof Pedestal fountain shall be factory-assembled with cast iron base and receptor shield. Receptor to be stainless steel with rounded corners, Projector shall be vandal-resistant, two stream, mound-building type, and shall have below frost line self-closing, foot operated valve, and diaphragm-type automatic stream regulator.

B. No lead solder shall be used in the fabrication of the waterways.

C. Fountain shall be Halsey Taylor Model 4880 or an approved equal.

3.11 IDENTIFICATION

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
White	Proposed Excavation

PART 3 – EXECUTION

3.1 INSPECTION

A. General: Examine areas and conditions under which potable water system's materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Engineer.

B. The Contractor is responsible for the provisions and all test requirements specified in herein. In addition, all pipe and appurtenances may be inspected at the plant for compliance with these specifications by an independent testing laboratory.

C. All tests shall be made in accordance with the methods prescribed by the above-mentioned AWWA Standards, and the acceptance or rejection shall be based on the test results.

D. Inspection of the pipe and appurtenances may also be made after delivery. The pipe and appurtenances shall be subject to rejections at any time on account of failure to meet any of the specifications requirements, even though samples may have been accepted as satisfactory at the place of manufacture.

E. Pipe which does not conform to the requirements of this contract shall be immediately removed and replaced by the Contractor at no cost to the Owner.

3.2 HANDLING PIPE

A. The Contractor shall take care not to damage pipe by impact, bending, compression, or abrasion during handling, and installation. Joint ends of pipe especially shall be kept clean.

B. Pipe shall be stored above ground at a height no greater than 5-feet, and with even support for the pipe barrel.

C. Only nylon-protected slings shall be used for handling the pipe. No hooks, chains or bare cables will be permitted.

D. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

3.3 INSTALLATION OF PIPE AND PIPE FITTINGS

A. The Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross-connections, whether or not specifically stated in the Contract Drawings and Specifications.

B. Care shall be taken in loading, transportation, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before placement, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer or Owner's Representative.

C. If any defective pipe is discovered after it has been placed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense. All pipe and fittings shall be kept clean until they are used in the work, be thoroughly cleaned before placement, and when placed, shall conform to the lines and grades required. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm even bearing throughout the length of the pipe shall be constructed by compacting sand gravel borrow around the pipe and up to 18 inches above the pipe.

D. Blocking will not be permitted.

E. A minimum horizontal separation of ten (10) feet shall be maintained between and existing, proposed or relocated sewer and the new water main. The distance shall be measured edge to edge. In cases where it is not practical to maintain a ten foot separation, it is permitted to install a water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located eighteen (18) inches above the top of sewer. Where the horizontal clearance is less than ten (10) feet or the vertical clearance is less than eighteen (18) inches and the sewer crosses under the water main, both water main and sewer main shall be constructed of mechanical joint cement lined ductile iron pipe for a distance of 10-feet on either side of the crossing. One (1) full length of water pipe shall be centered over the sewer at the crossing. If the sewer crosses over the water main, regardless of the vertical separation, both pipes shall be concrete encased for a distance of ten (10) feet to either side of the respective centerline.

F. Provide minimum cover over piping of 5-feet below finished grade.

A. Extend water systems from the water main located within the public way and terminate portable water piping 10-feet 0-inches from the building foundation. Provide temporary pipe plug for piping extension into building if required by construction progress.

B. All pipes shall be sound and clean before placement. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be temporarily closed by watertight plug or other acceptable means. Alignment shall be maintained during placement. The deflection at joints shall not exceed sixty percent of that recommended by the manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities, which may be encountered upon opening the trench. Solid sleeves shall be used only where allowed by the Engineer.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on type bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be inspected for damage and shall be remortared as required to ensure a continuous lining.

D. Mechanical joint restraints shall be used for all valves, bends, hydrants and piping section less than 50 feet. The contractor shall restrain all pipe runs to the lengths indicated on the approved restrained joint calculation shop drawings.

E. Jointing of ductile iron push-on pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8-inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to insure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

1. Jointing Ductile Iron Pipe (Push-On Type): Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.
2. Jointing Mechanical Joint Fittings: Mechanical joints at valves, fittings, and where designated shall be installed in accordance with the "Notes on Method of Installation" under ANSI Specification A 21.11 and the instructions of the manufacturer. To assemble the joints in the field, the Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipes over handles or ordinary ratchet wrenches be used to secure greater leverage.

F. Installation and jointing of ductile iron pipe shall be in accordance with AWWA C600, Sections 9b and 9c, latest revision, as applicable.

G. Ductile iron pipe installed within 5-feet of gas lines shall be fully encased with polyethylene material. Polyethylene shall be 8-millimeters thick and comply with AWWA C-105.

H. Service tubing shall be installed with minimum 6-inches of sand bedding and 12-inches sand cover. Service tubing shall have a minimum total cover of 5 feet.

3.4 INSTALLATION OF VALVES AND APPURTANCES

A. Cleaning And Prime Coating Valves And Appurtenances (Except Epoxy Coated Valves)

1. Prior to shop prime coating, all surfaces of the valves and appurtenances shall be thoroughly clean, dry, and free from all mill-scale, rust, grease, dirt, paint and other foreign substances to the satisfaction of the Engineer or Owner’s Representative.
2. All ferrous surfaces shall be sand blasted or pickled according to SSPC-SP6 or SSPC-SP8, respectively.
3. All gears, bearing surfaces and other surfaces not to be painted shall be given a heavy coat of grease or other suitable rust resistant coating unless otherwise specified herein. This coating shall be maintained as required to prevent corrosion during any period of storage and installation and shall be satisfactory through the time of final acceptance.

B. INSTALLATION

1. All valves and appurtenances shall be installed in the location shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired before they are installed.
2. Care shall be taken to prevent damage to valves and appurtenances during handling and installation. All materials shall be carefully inspected for defects in workmanship and materials, all debris and foreign material cleaned out of valve openings, etc., and all operating mechanisms operated to check their proper functioning, and all nuts and bolts checked for tightness. Valves and other equipment that do not operate easily, or are otherwise defective, shall be repaired or replaced.

C. SHOP PAINTING VALVES AND APPURTENANCES

1. Interior and exterior surfaces of all valves which are not factory epoxy coated shall be given two coats of shop finish of an asphalt varnish conforming to AWWA C504 for Varnish Asphalt. The pipe connection openings shall be capped to prevent the entry of foreign matter prior to installation.

D. BURIED VALVES

1. Install valves as indicated with stems pointing up. Provide valve box over underground valves. Buried valves and boxes shall be set with the operating stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping selected excavated material under and at the sides of the valve.

E. VALVE BOXES

1. Valve boxes shall be installed vertically, centered over the operating nut, and if they are in the limits of the roadway or within limits where the plowing of snow will take place in the winter, the tops of the boxes shall be set ½" below the top of the finished grade. In locations where these boxes are not likely to be disturbed, the tops shall be set flush with the adjoining ground. Boxes shall be adequately supported during backfilling to maintain vertical alignment.

F. CORPORATION COCKS

1. The tapping machine shall be rigidly fastened to the pipe as near the horizontal diameter as possible. The length of travel of the tap should be so established that when the stop is inserted and tightened with at 14" wrench, not more than one to three threads will be exposed on the outside. When a wet tapping machine is used, the corporation stop shall be inserted and tightened in accordance with the manufacturer's specifications.

3.5 INSTALLATION OF HYDRANTS

A. Hydrants and hydrant branches shall be tested at 175 psi and chlorinated as specified in this specification.

B. Hydrants shall be installed in conformance to AWWA C 600, Section 11, latest revision, using thrust blocks and restrained joints in accordance with the details shown on the Contract Drawings.

C. Hydrants as detailed on the Contract Drawings shall be set at the locations designated by the Engineer and shall be bedded on a firm foundation. A drainage pit 2-feet 6-inches in diameter and to the limits shown on the Contract Drawings shall be filled with crushed stone and satisfactorily compacted. During backfilling, additional crushed stone shall be brought up around, and 6-inch

over the drain port. Each hydrant shall be set in true vertical alignment and shall be properly braced. Thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Hydrant shall be set upon a slab of concrete not less than 4-in thick and 15-in square.

D. Hydrants shall be set plumb with the steamer nozzle facing the roadway and the center of the operating nut located 18-inches back from the face of curb or edge of pavement.

E. Hydrants shall be set such that the bottom of the breakaway feature shall be a minimum of 2-inches and a maximum of 4-inches above finish grade.

F. Once installed, hydrants shall be painted once again by the Contractor. Hydrants shall be painted in accordance with the Owner's requirements.

G. All iron work to be set below ground, after being thoroughly cleaned, shall be painted with two coats of asphalt varnish as specified in AWWA C502, latest revision and iron work to be left above ground shall be shop painted with two coats of paint.

H. Thrust Blocks: Concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Contract Drawings. Felt paper shall be placed as shown on the Contract Drawings. Care must be taken to ensure that concrete does not plug the drain ports.

3.6 BACKFILLING

A. General: Conduct backfill operations of open-cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed, all in accordance with local requirements and the contract documents.

B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.7 FIELD QUALITY CONTROL

A. Testing of Water Main/Service:

1. Prior to pressure testing, the entire line shall be water jetted to remove any rocks or debris that may have inadvertently entered the pipe during construction.
2. The Contractor in accordance with AWWA C651-99 specifications or latest revision will make pressure and leakage tests thereof, to determine that the ductile iron pipe is structurally safe and free of excess leakage. Pipeline shall be subject to a hydrostatic test of 150 pounds per square inch (psi) or 150% of the static pressure, whichever is greater. The Contractor shall furnish all equipment, materials and labor for testing. Testing shall be done between valved off sections in approximately 1000-foot maximum section of the main. The Contractor shall furnish at his own expense the water needed for all water main testing.
3. Once the pipeline section has been filled at normal pressure and all entrapped air removed from the line, the Contractor shall raise the pressure to the approved test pressure by a special pressure pump taking water from a small tank of proper dimensions for satisfactorily measuring the rate of pumpage into the pipeline. The pipe shall maintain this pressure, within 5 psi, for a minimum of two hours during which time the line shall be checked for leaks. The measured water leakage shall not exceed the maximum allowed leakage as determined by the following equation for the section under test:

$$L = \frac{SDP^{1/2}}{133{,}200}$$

Where:
L = Allowable leakage, gallons per hour
S = Length of pipe section tested, feet (1,000-foot maximum)
D = Nominal pipe diameter, inches.
P=Average test pressure (psi)

Should leakage exceed this rate, the Contractor shall immediately locate the leak or leaks and repair same at his expense. Pipe shall be flushed and chlorinated when leakage does not exceed above standard. Approval does not absolve the Contractor from his responsibility if leaks develop within the new main or water services (to curb box) later within the period of warranty.

B. Testing of Fire protection service:

1. Testing of fire protection services shall conform to the most current NFPA requirements.

C. Chlorinating and Flushing:

1. Prior to chlorination, the Contractor shall properly flush mains. In general, flushing shall be performed at a flow rate required to achieve a minimum velocity of 2.5-feet per second (approximately 900 GPM in a 12-inch diameter main and 400 GPM in 8-inch diameter main). Flushing shall be performed for a sufficient period of time to allow for a minimum of 3 volume changes of water in the main (approximately 20 minutes per 1,000-foot of 8-inch main at the above flow rate).
2. Chlorinating shall be accomplished by pumping a chlorine solution into the mains. Water shall be allowed to enter the new water mains until the mains are full of a solution containing 25-ppm available chlorine. The valves shall then be closed and the chlorinated water allowed to stay in the mains for 24 hours. At the end of this period, the chlorine residual shall be at least 10 mg/l. If it is less than 10 mg/l measured, Contractor shall flush and rechlorinate the mains at no cost to the Owner. All valves and hydrants shall be operated to insure their proper disinfection and shall be manipulated to prevent superchlorinated water from entering the existing distribution system. After this period, the Contractor shall flush the mains until clear, clean water is being discharged.
3. Chlorinating and flushing shall be done in accordance with AWWA C651-99 Specifications.
4. Twenty-four hours after the main has been flushed of chlorinated water, bacteriological samples shall be taken. Water samples shall be taken from corporation stops along the length of the water main as designated by the Engineer. A minimum of two (2) samples shall be taken, per 3,000 foot of pipe or on each street, whichever is greater, each in duplicate, in sterile bottles and sent to a State approved private laboratory for analyses. The Contractor shall perform all necessary work including delivery of samples to a certified laboratory, and shall include the cost for sampling and analysis in his bid price. The results of the tests on these samples will determine the acceptance of the work and allow these new mains to be connected to the District's system. The failure of any sample to pass the laboratory tests shall require the Contractor to reflush and rechlorinate the mains and resample and test the water until acceptable results are obtained, all at no additional cost to the Owner.
5. The Contractor shall submit a Disinfection report detailing the following:
   a. Type and form of disinfectant used.
   b. Date and time of disinfectant injection start and time of completion.
   c. Test locations.

d. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
e. Date and time of flushing start and completion.
f. Disinfectant residual after flushing in ppm for each outlet tested.

6. The Contractor shall submit a Bacteriological Report detailing the following:
   a. Date issued, project name, and testing laboratory name, address, and telephone number.
   b. Time and date of water sample collection.
   c. Name of person collecting samples.
   d. Test locations.
   e. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
   f. Coliform bacteria test results for each outlet tested.
   g. Certification that water conforms, or fails to conform, to bacterial standards.
7. Contractor shall note that work under this Contract shall NOT be considered completed until satisfactory installation and testing of the water mains have been completed.

3.8 FINAL INSPECTION

A. Final inspection and acceptance of pipe, valves, appurtenances, and precast concrete structures shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system. Prior to placing the systems in service all components shall be inspected, with the Owner's Representative present, to insure that no debris or other contaminants are present. If necessary, the Contractor shall clean the structures and flush piping.

B. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

END OF SECTION 331000

SECTION 33 31 00

WASTEWATER COLLECTION

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Sanitary sewage system piping, structures and appurtenances from a point ten (10) feet outside the building to the point of disposal.

B. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 311000 – SITE CLEARING for site clearing, removal of trees, stumps and other vegetation, topsoil stripping, stockpiling and clearing and grubbing.

2. Section 312000 – EARTH MOVING for excavation, backfill, and compaction required for sanitary sewerage system piping and structures.

3. Section 221316 – SANITARY WASTE AND VENT PIPING for building sanitary drains.

1.3 SUBMITTALS

A. Refer to Section 013300 – SUBMITTAL PROCEDURES for submittal provisions and procedures.

1. Descriptive literature showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.

2. Product Data: Submit manufacturer's technical product data and installation instructions for pipe fittings, couplings, and appurtenances.

3. Shop Drawings: The precast concrete structure shop drawing submittals for the manholes, septic tanks, tight tank, and grease trap shall contain erection drawings showing connections, cast-in items, waterproofing details, lifting hooks, and production drawings showing elevations, sections and details indicating sizes and quantities of reinforcement. For manholes, shop drawings shall indicate orientation, size, and elevation of openings. Submit shop drawings for structure frames and covers.

4. Material Certificates: Provide copies of material certificates signed by material producer and Contractor, certifying that each material item complies with, or exceeds, specified requirements.

5. Prior to the acceptance of the sanitary sewerage system, the Contractor shall submit to the Engineer, for review and approval, a system As-Built Plan stamped by a Professional Land Surveyor. As-Built Plans shall be prepared using AutoCAD Release 14 or higher. The Owner's Representative will furnish to the Contractor an AutoCAD electronic file.

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. ASTM: American Society for Testing and Materials.

2. ANSI: American National Standards Institute.

3. Commonwealth of Massachusetts Plumbing Code, latest edition.

4. Commonwealth of Massachusetts State Environmental Code Title V, 310 CMR 15.00, latest revision.

5. Local Board of Health Regulations

1.5 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 QUALITY ASSURANCE

A. Environmental Compliance: Comply with applicable portions of local environmental agency regulations pertaining to sanitary sewerage systems.

B. Utility Compliance: Comply with local utility owner's regulations and standards pertaining to sanitary sewerage system installation and inspection.

1.7 PROJECT CONDITIONS

A. Site Information: Perform site inspection and survey, research utility records, and verify existing utility locations and elevations. Verify that sewerage system piping may be installed in compliance with Contract Drawings and referenced standards.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate with interior building sanitary sewerage system piping.

B. Coordinate with other utility work.

C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.

D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2 – PRODUCTS

2.1 PRECAST CONCRETE VAULTS AND TANKS

A. The precast reinforced concrete vault and tank structures shall be designed by a Massachusetts Registered Professional Engineer employed by the Contractor, in accordance with the applicable sections of the following references:

1. Commonwealth of Massachusetts State Building Code, latest edition.

2. American Concrete Institute, ACI 318 "Building Code Requirements for Reinforced Concrete."

3. AASHTO, "Standard Specifications for Highway Bridges."

4. Precast Concrete Institute, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, MNL-116."

B. The structures shall be designed for the following loads and possible combinations thereof:

1. Lateral soil pressure = 60 PCF (H), where H is the height from grade, as shown on the Contract Drawings, to the point of the structure being considered.

2. Soil weight shall be assumed to be 120 PCF.

3. AASHTO HS-20-44 loading.

4. Weight of precast concrete structure.

5. Initial handling and erection loadings, including design of galvanized lifting hooks using a safety factor = 4.0.

C. Investigate buoyancy and soil bearing considerations assuming the groundwater elevation is one-foot below the ground surface.

D. Concrete shall have a minimum 28 day compressive strength of 5,000 psi using Type II or III Portland cement with 8% maximum content of tricalcium aluminate, ASTM C150. A "normal dosage" of air-entraining agent shall be added to the concrete during the mixing cycle. Reinforcement shall be deformed billet-steel ASTM A615 or 7-wire strand ASTM A416, Grade 270 (if prestressed).

E. Dimensions and opening sizes and locations shall be as indicated on the Contract Drawings.

F. All concrete surfaces shall have a smooth finish, and the outside of the structures shall be coated with two coats of bituminous dampproofing. Bituminous dampproofing materials shall comply with Federal Specification SS-A-701. Each coat shall be applied at a rate of 65-square feet per gallon.

2.2 MANHOLES

A. General: Provide precast reinforced concrete structures as indicated and complying with ASTM C

478.

B. Manhole Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated in the Contract Drawings. Tops shall be designed to meet H20 loadings.

C. Base and Riser Sections: Precast concrete, with base riser section with integral floor. Diameter, base and riser thicknesses shall be as indicated on the Contract Drawings.

D. Cement: Type II.

E. Concrete strength: 4,000 psi minimum.

F. Horizontal Joints: Joints between sections of concrete structures shall be sealed with a self-sealing butyl rubber based flexible joint sealant gasket complying with ASTM C443. Sealant shall be installed in accordance with the manufacturer's written instructions.

G. Manhole Steps and 1/2-inch grade 60 steel reinforcing rod conforming to ASTM A615 encapsulated with molded copolymer polypropylene. Rungs shall have a 14-inch-wide stepping surface and protrude no more than 6 inches from the wall, M.A. Industries type PS-2-PR-SL or equal. Copolymer polypropylene shall be type II, grade 16906, meeting ASTM specifications D 4101. The portion of the legs to be embedded in the precast section shall have fins and be tapered to ensure a secure bond. Steps shall start a foot above the shelf of the manhole floor and continue twelve inches on center spacing up through the complete height of the unit. The steps shall finish no lower than twenty-four (24)-inches below the rim elevation.

H. Pipe Connections: Sewer manhole pipe openings shall have integral flexible rubber sleeves capable of accepting the pipe connection.

I. Bituminous Dampproofing: Sewer manholes shall receive two coats of bituminous dampproofing, which complies with Federal Specification SS-A-701. Each coat shall be applied at a rate of 65-square feet per gallon.

J. Sanitary Sewer Brick Masonry: Bricks shall be sound, hard, uniformly burned, regular, and uniform in shape and size. Underburned or salmon brick shall not be acceptable. Only whole brick shall be used.

1. Bricks for channels and shelves shall conform to ASTM C32, Grade SS except that the mean of five tests for absorption shall not exceed 8 percent and no individual brick exceed 11 percent.

2. Bricks for raising manhole frames to finished grade shall conform to ASTM C62.

3. Mortar shall be composed of one part Portland cement, two parts sand, and hydrated lime not to exceed 10 lbs. To each bag of cement. Portland cement shall be ASTM C150, Type II; hydrated lime shall conform to ASTM C207.

4. Sand shall be washed, cleaned, screened, well-graded with all particles passing a No. 4 sieve, and conform to ASTM C33.

K. In sewer manholes, the invert channel within the structure shall be an inverted arch with bricks laid as stretchers and on edge and so constructed as to conform in shape to the lower half of the pipe. The shelf in manholes shall consist of bricks laid flat and the top of the shelf shall be at the elevation of the top of the pipe, as indicated on the Contract Drawings, and shall be sloped to flow toward the channel.

L. Inverts in sewer manholes shall conform accurately to size of the adjoining pipe. Side inverts and main inverts where the direction changes shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerline of the adjoining pipe lines.

M. When installing manholes on existing lines and when flows cannot be diverted, drop-over manholes shall be used. Drop-over manholes shall be precast with opening cast in the sidewalls of sufficient size to fit over the existing line(s) to remain in service. Drop-over manholes shall be set on a precast or cast-in-place concrete base slab. Drop-over manholes shall be manufactured to the same requirements and dimensions as standard manholes.

2.3 CONCRETE BLOCK MANHOLES

A. Concrete block manholes shall only be utilized when it is not feasible to utilize a precast concrete manhole and then only with written approval from the Owner's Representative.

B. Concrete block manholes shall be minimum 48 inches inside diameter and built of standard solid manhole barrel blocks set on a concrete or precast sectional plate base. The upper 2 feet of masonry shall be built using batter blocks. All joint spaces shall be completely filled, horizontal and vertical. All block to be thoroughly wet before jointing. A leveling course of two bricks at the top shall be used to meet proper grade. Cement concrete blocks shall be machine-made solid segments conforming to the requirements for Concrete Masonry Units for Construction of Catch Basin and Manholes, ASTM-C-139. Blocks shall be 6 inches in width with the inside and outside surfaces curved to the necessary radius and so designed that the interior surfaces of the structures shall be cylindrical. The top batter courses shall be designed to reduce uniformly the inside section of the structure to the top size and shape. The blocks used in the top courses shall be designed to produce a surface 8 inches in width upon which to seat the frame.

2.4 MANHOLE FRAMES AND COVERS

A. Frames and covers shall be of cast iron conforming to the requirements of ASTM A48, Class No. 30 and shall be manufactured by LeBaron Foundry, Inc. Brockton, Massachusetts, Neenah Foundry Company, Neenah, Wisconsin, Mechanics Iron Foundry Company, Roxbury, Massachusetts, or equal. Manhole covers shall be machined to fit securely and evenly on the frame. Frames and covers shall be designed to accept H20 loads, have a diamond surface finish, and frame height of 6 to 9-inches. Covers shall bear the word "SEWER" in 3-inch-high letters.

2.5 PVC PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

B. PVC SEWER PIPE

1. PVC (Polyvinyl Chloride) Gravity Sewer Pipe: ASTM D3034, SDR 35, for elastomeric gasket joints. Pipe 18 to 27 inches in diameter shall conform to ASTM F679, T-1 heavy wall.

a. Fittings: Elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477.

C. PVC CONDUIT

1. PVC Schedule 40: Provide PVC pipe Schedule 40 where shown on the Contract

Drawings. Pipe shall comply with ASTM D1785 and be manufactured from virgin PVC plastic conforming to ASTM D1784. Pipe shall be Underwriter's Laboratories listed for use in underground installations.

a. Joints and solvent cements shall conform to ASTM 2564.

2.6 CLEANOUTS

A. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.

2.7 IDENTIFICATION

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
White	Proposed Excavation

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. General Locations and Arrangements: Contract Drawings indicate the general location and arrangement of the underground sanitary sewer system piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. Any modifications to the layout of the sewer system shall be submitted to the Engineer for review and approval at least five days prior to the start of the affected work.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations, accepted practices, and utility owner's requirements. Maintain swab or drag in line and pull past each joint as it is completed.

C. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited without the written approval of the Engineer.

E. Install piping pitched down in direction of flow, at minimum slope of 1/4-inch per foot, except

where indicated otherwise on the Contract Drawings.

F. Extend sanitary sewerage system piping to connect to building sanitary drains, of sizes and in locations indicated on the Contract Drawings.

3.2 CONCRETE STRUCTURES

A. The bases shall be supported on a compacted level foundation of gravel borrow a minimum 12 inches thick. Crushed stone may be substituted for gravel borrow if field conditions at the bottom of the excavation are wet.

1. Manhole risers and tops shall be installed using approved butyl-rubber type gasket for sealing joints of manhole risers and tops; jointing shall be performed in accordance with the manufacturer's recommendations. Manhole risers and tops shall be installed level and plumb. Water shall not be permitted to rise over newly made joints, nor until after inspection as to their acceptability. All jointing shall be done in a manner to ensure watertight joints. Openings shall be provided in the precast concrete manhole risers to receive entering pipes and these openings shall be made at the place of manufacture. Connection of sanitary pipes to manholes shall be made by means of a flexible rubber sleeve/boot cast integral with the structure sidewall.

2. Care shall be taken to ensure the openings are made to permit setting of the entering pipe at its correct elevation as indicated or directed. Manhole risers and tops shall be installed so the manhole steps shall be in alignment.

3. All holes used for handling shall be thoroughly plugged with non-shrink grout.

4. Cutting or tampering in the field, for purpose of creating new sidewall openings or altering existing openings, will not be permitted without approval of the Engineer.

5. Clean all debris, mortar, and soil from the bottom of all structures prior to final acceptance of the project.

3.3 STRUCTURE REBUILT

A. When in the opinion of the Engineer or Owner's Representative, an existing masonry structure walls show deterioration, the structure shall be rebuilt. The casting and deteriorated masonry shall be removed in a careful and neat manner until only a sound condition remains. Concrete blocks shall be used to rebuild the structure. The new masonry construction, replacing of the casting, and other incidental work shall be performed as specified above.

1. The Contractor's base bid shall include rebuilding 50 vertical linear feet of existing manhole or catch basin structures.

3.4 INSTALLATION OF TANKS

A. If precast tank sections are to be field assembled, adequate waterproofing shall be used at the joint to resist the waterhead at that joint.

B. Structure shall be supported on a compacted level foundation of gravel borrow a minimum of 12 inches thick.

3.5 SETTING MANHOLE FRAMES AND COVERS

A. Manhole frames shall be set with tops conforming accurately to the grade of the pavement or

finished ground surface as indicated on the Contract Drawings or as directed. Frames shall be set concentric with the top of the manhole on a minimum of two courses of brick and a maximum of four courses in a full bed of mortar so the space between the top of the brick and mortar and the bottom flange of the frame shall be completely filled and made watertight. A thick ring of mortar extending to the outer edge of the concrete shall be placed all around the bottom flange. The mortar shall be smoothly finished to a height of 5 inches above the flange.

1. Only clean bricks shall be used in brick work to adjust frame elevations. The brick shall be moistened by suitable means.

2. Manhole covers shall be left in place in the frame until completion of other work at the manholes.

3. Frame castings for catch basins shall be set on a minimum of two courses of brick and a maximum of four courses in full mortar beds true to line and grade. Frames shall be set in a grout bed and the cement mortar shall be brought up to a height of not less than 5 inches above the bottom of the frames and made watertight. The castings of structures located within the pavement area shall not be completely set to the established grade until the bottom course of pavement has been laid. The final setting of all casting shall be performed at the proper stage of construction as required by the Contractor's operations. No additional payment will be made for adjusting and resetting of any casting.

3.6 PVC PIPE

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. PIPE HANDLING

1. All pipe and fittings shall be carefully handled from the truck onto the ground and into the trench or excavation so as to prevent damage to the pipe. Pipes shall be kept free of dirt and foreign material especially on the inside. Joint ends of pipe shall especially be kept clean.

2. Pipe stored on site shall be protected from direct sun light and suitably ventilated.

3. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

C. ALIGNMENT AND PLACEMENT OF PVC PIPE

1. Bedding material for the pipe must be installed with care in the area around the pipe. Bedding material must be placed to provide uniform and adequate support under pipe. Do not use blocking to bring pipe up to grade.

2. Provide bell holes at each joint to permit joint to be assembled properly while maintaining uniform pipe support.

3. Place and consolidate the bedding material under the pipe haunch to provide adequate side support while avoiding both vertical and lateral displacement of pipe.

4. Initial backfill must be completed to a point at least 12-inches over the top of the pipe and be hand placed. Use little or no tamping of initial backfill directly over the top of pipe. Compaction methods may be utilized during final backfilling.

5. Jointing of PVC sewer pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The bell end of the pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be lubricated prior to making up the joint. The position of the gasket shall be checked to insure the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

6. When jointing PVC conduit pipe, it shall be cut square, conduit ends cleaned, an even coating of solvent cement applied to the pipe end and socket, and the conduit firmly pushed together until the conduit bottoms in the socket. The conduit shall be rotated 1/4 turn immediately after bottoming in the socket to ensure even spread of the cement.

7. Detectable warning tape shall also be installed 2-feet below the existing ground surfaces for later use in locating the pipe's exact position.

3.7 CLEANOUTS

A. Install cleanouts and extensions from sewer pipe to grade as indicated on the Contract Drawings. Set cleanout frame and cover in concrete 12 by 12 by 6-inches deep, except where location is in bituminous or concrete paving. Set top of cleanout 1-inch above surrounding earth grade or flush with grade when installed in paving.

3.8 TAP CONNECTIONS

A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work.

B. Make branch connections from side into existing piping by installing a saddle or wye as indicated on the Contract Drawings.

C. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

3.9 INSTALLATION OF IDENTIFICATION

A. Install continuous plastic underground warning tape during back-filling of trench for underground sanitary sewerage system piping. Locate tape two-feet below finished grade, directly over piping.

3.10 FIELD QUALITY CONTROL

A. Testing: Perform testing of completed piping in accordance with local authorities having jurisdiction and the following:

1. Testing shall be witnessed by the Owner’s Representative and the local authority.

2. All sewers shall be tested for leakage by an infiltration test if the groundwater level is a minimum of two feet above the crown of the pipe for the full length of the section to be tested.

3. Where sewers cannot be tested by an infiltration test as specified above, they shall be tested by an exfiltration test using air as specified in a document entitled, "Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe”, by UNI-BELL PVC Pipe Association dated July, 1998 (UNI-B-6-98).

B. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work

progresses. Maintain swab or drag in piping and pull past each joint as it is completed.

1. In large, accessible piping, brushes and brooms may be used for cleaning.

2. Place plugs in ends of uncompleted pipe at end of day or when work stops.

3. Flush piping between manholes to remove collected debris.

C. Interior Inspection: If deemed necessary by the Owner's Representative inspect piping to determine whether line displacement or other damage has occurred.

1. Make inspections after pipe between manholes has been installed and approximately 2 feet of backfill is in place, and again at completion of project.

2. If inspection indicates poor alignment, debris, displaced pipe, infiltration or other defects, the Contractor shall correct such defects and reinspect.

D. Prior to acceptance of the sanitary sewerage system the Contractor shall submit to the Engineer for review a system As-Built Plan stamped by a Professional Land Surveyor Registered in the Commonwealth of Massachusetts and the results of the leakage tests. Prior to putting the system into service all structures shall be inspected, with the Owner's Representative present, to insure that no debris or other contaminants are present. If necessary clean structures and flush piping.

3.11 BACKFILLING

A. General: Conduct backfill operations of open-cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed, all in accordance with local requirements and the contract documents.

B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.12 FINAL INSPECTION

A. Final inspection and acceptance of pipe, valves, appurtenances, hydrants and precast concrete structures shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system. Prior to placing the systems in service all components shall be inspected, with the Owner's Representative present, to insure that no debris or other contaminants are present. If necessary, the Contractor shall clean the structures and flush piping.

B. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

END OF SECTION 33 31 00

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.2 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Ductile iron pipe
2. Polyvinyl chloride pipe.
3. Reinforced concrete pipe.
4. Corrugated polyethylene pipe.
5. Drainage vaults, tanks, catch basins, and manholes
6. Area drains and trench drains
7. Stormwater Chambers
8. Water quality structures

B. Related Work: The following items are noted and included in this Section and will be performed under the designated sections:

1. Section 31 20 00 – EARTH MOVING for excavation, backfill, & compaction requirements.
2. Section 22 14 00 – FACILITY STORM DRAINAGE for building storm drainage piping.

1.3 SUBMITTALS

A. Refer to Section 01 33 00 – SUBMITTAL PROCEDURES, for submitted provisions and procedures.

1. Product Data: Submit manufacturer's technical product data and installation instructions for storm drain system materials and products. Descriptive literature showing pipe dimensions, pipe and joint materials and dimensions, and other details for each class or type of pipe or product to be furnished for this contract. All pipe furnished under the contract shall be manufactured in accordance with these Specifications.
2. Submit shop drawings for storm drain systems, showing piping and manhole materials and sizes. Submit shop drawings of complete layout of detention/retention structures, including all fittings and appurtenances.
3. The precast concrete structure shop drawing submittals for the manholes, catch basins, vaults,

and tanks shall contain erection drawings showing connections, cast-in items, waterproofing details, lifting hooks, and production drawings showing elevations, sections and details indicating sizes and quantities of reinforcement.

4. For manholes, clock diagrams shall be submitted indicating orientation, size, and elevation of openings for each manhole structure.

5. Submit shop drawings for structure frames, grates, and covers.

6. Filter fabric: Submit the manufacturer's information and a one square foot representative sample of the filter fabric.

7. The Contractor shall submit buoyancy calculations for storm drainage structures prepared and sealed by a professional Civil Engineer and licensed in the state of Massachusetts.

8. Record Drawings: Prior to the acceptance of the storm drainage system, the Contractor shall submit to the Engineer, for review and approval, As-Built Drawings that indicate the true measurement and location, horizontal and vertical, of all new construction. As-Built Drawings shall include a minimum of three (3) ties to each structure from fixed permanent objects. As-Built drawings shall be stamped and signed by a Massachusetts Licensed Land Surveyor and Licensed Professional Engineer. The as-built plans shall also be submitted electronically as an AutoCAD drawing file (release 2002 or higher).

1.4 REFERENCE STANDARDS

A. The following standards are applicable to the work of this Section to the extent referenced herein:

1. ASTM: American Society for Testing and Materials.

2. ANSI: American National Standards Institute.

3. AASHTO: American Association of State Highway and Transportation Officials

4. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), Formerly Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.

5. Commonwealth of Massachusetts, Massachusetts Highway Department, Construction Standards, latest Edition with amendments, hereinafter referred to as the “Construction Standards.”

6. Plumbing Code Compliance: Comply with applicable portions of Massachusetts Plumbing Code and National Standard Plumbing Code, latest editions, pertaining to selection and installation of storm drain system's materials and products.

7. Environmental Compliance: Comply with applicable portions of local Environmental Agency regulations pertaining to storm drain systems.

8. City/Town Regulations

1.5 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge

of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturing of storm drain system's products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five years.

B. Installer's Qualifications: Firms with at least three years of successful installation experience on projects with storm drain work similar to that required for the project.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate with interior building storm drain system piping.

B. Coordinate with other utility work.

C. The Contractor is responsible for developing a sequence of work to maintain existing services in operation until the new services are operational.

D. The Contractor is responsible for coordinating and scheduling the inspection of the work by the jurisdictional authority. All permits and inspection costs and fees shall be included in the bid prices and no additional costs will be paid to the Contractor.

PART 2 – PRODUCTS

2.1 PRECAST CONCRETE VAULTS AND TANKS

A. The precast reinforced concrete vault and tank structures shall be designed by a Massachusetts Registered Professional Engineer employed by the Contractor, in accordance with the applicable sections of the following references:

1. Commonwealth of Massachusetts State Building Code, latest edition.

2. American Concrete Institute, ACI 318 "Building Code Requirements for Reinforced Concrete."

3. AASHTO, "Standard Specifications for Highway Bridges."

4. Precast Concrete Institute, "Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products, MNL-116."

B. The structures shall be designed for the following loads and possible combinations thereof:

1. Lateral soil pressure = 60 PCF (H), where H is the height from grade, as shown on the Contract Drawings, to the point of the structure being considered.

2. Soil weight shall be assumed to be 120 PCF.

3. AASHTO HS-20-44 loading.

4. Weight of precast concrete structure.

5. Initial handling and erection loadings, including design of galvanized lifting hooks using a safety factor = 4.0.

C. Investigate buoyancy and soil bearing considerations assuming the groundwater elevation is one-foot below the ground surface.

D. Concrete shall have a minimum 28 day compressive strength of 5,000 psi using Type II or III Portland cement with 8% maximum content of tricalcium aluminate, ASTM C150. A "normal dosage" of air-entraining agent shall be added to the concrete during the mixing cycle. Reinforcement shall be deformed billet-steel ASTM A615 or 7-wire strand ASTM A416, Grade 270 (if prestressed).

E. Dimensions and opening sizes and locations shall be as indicated on the Contract Drawings.

F. All concrete surfaces shall have a smooth finish, and the outside of the structures shall be coated with two coats of bituminous dampproofing. Bituminous dampproofing materials shall comply with Federal Specification SS-A-701. Each coat shall be applied at a minimum thickness of 7 mils per coat and a total thickness of 14 mils; however, in no case shall the thickness per coat be less than that recommended by the manufacturer. Bituminous waterproofing shall be Carboline Bitumastic 300M as manufactured by SOMAY Products, Inc., Miami, FL; Sonnoshield HLM 5000 as manufactured by Sonneborn, Shakopee, MN, or approved equal.

2.2 MANHOLES AND CATCH BASINS

A. General: Provide precast reinforced concrete structures as indicated and complying with ASTM C 478.

B. Manhole Top: Precast concrete, of concentric cone, eccentric cone, or flat slab top type, as indicated in the Contract Drawings. Tops shall be designed to meet H20 loadings.

C. Base and Riser Sections: Precast concrete, with base riser section with integral floor. Diameter, base and riser thicknesses shall be as indicated on the Contract Drawings.

D. Cement: Type II.

E. Concrete strength: 4,000 psi minimum.

F. Horizontal Joints: Joints between sections of concrete structures shall be sealed with a self-sealing butyl rubber based flexible joint sealant gasket complying with ASTM C443. Sealant shall be installed in accordance with the manufacturer's written instructions.

G. Manhole Steps and 1/2-inch grade 60 steel reinforcing rod conforming to ASTM A615 encapsulated with molded copolymer polypropylene. Rungs shall have a 14-inch-wide stepping surface and protrude no more than 6 inches from the wall, M.A. Industries type PS-2-PR-SL or equal. Copolymer polypropylene shall be type II, grade 16906, meeting ASTM specifications D 4101. The portion of the legs to be embedded in the precast section shall have fins and be tapered to ensure a secure bond. Steps shall start a foot above the shelf of the manhole floor and continue twelve inches on center spacing up through the complete height of the unit. The steps shall finish no lower than twenty-four (24)-inches below the rim elevation.

H. Pipe Connections: Drainage structures shall have plain beveled openings to accept the type of pipe specified and to be sealed with non-shrink grout.

I. Drain manholes shall be constructed with drop connections when the proposed invert of the

connection is at least 2.75 feet above the manhole invert. All drop manholes will be of the external type. The drop pipe shall be constructed of minimum SDR 35 PVC. The drop piping and horizontal cleanout sections will be sized the same as the drain main piping and shall enter the manhole at invert elevation. The drop portion of the piping shall be secured with anchor straps. The drop piping shall be encased with control density fill.

J. Bricks for raising manhole frames to finished grade shall conform to ASTM C32 or as specified in MHD M4.05.

K. Inverts in drain manholes shall conform accurately to size of the adjoining pipe. Side inverts and main inverts where the direction changes shall be laid out in smooth curves of the longest possible radius which is tangent, within the manhole, to the centerline of the adjoining pipe lines.

L. Safety landings will be installed inside manholes greater than 16-feet in depth.

M. When installing manholes on existing lines and when flows cannot be diverted, drop-over manholes shall be used. Drop-over manholes shall be precast with opening cast in the sidewalls of sufficient size to fit over the existing line(s) to remain in service. Drop-over manholes shall be set on a precast or cast-in-place concrete base slab. Drop-over manholes shall be manufactured to the same requirements and dimensions as standard manholes.

2.3 CONCRETE BLOCK MANHOLES

A. Concrete block manholes shall only be utilized when it is not feasible to utilize a precast concrete manhole and then only with written approval from the Owner's Representative.

B. Concrete block drain manholes shall be minimum 48 inches inside diameter and built of standard solid manhole barrel blocks set on a concrete or precast sectional plate base. The upper 2 feet of masonry shall be built using batter blocks. All joint spaces shall be completely filled, horizontal and vertical. All block to be thoroughly wet before jointing. A leveling course of two bricks at the top shall be used to meet proper grade. Cement concrete blocks shall be machine-made solid segments conforming to the requirements for Concrete Masonry Units for Construction of Catch Basin and Manholes, ASTM-C-139. Blocks shall be 6 inches in width with the inside and outside surfaces curved to the necessary radius and so designed that the interior surfaces of the structures shall be cylindrical. The top batter courses shall be designed to reduce uniformly the inside section of the structure to the top size and shape. The blocks used in the top courses shall be designed to produce a surface 8 inches in width upon which to seat the frame.

2.4 MANHOLE FRAMES AND COVERS

A. Frames and covers shall be of cast iron conforming to the requirements of ASTM A48, Class No. 30 and shall be manufactured by LeBaron Foundry, Inc. Brockton, Massachusetts, Neenah Foundry Company, Neenah, Wisconsin, Mechanics Iron Foundry Company, Roxbury, Massachusetts, or equal. Manhole covers shall be machined to fit securely and evenly on the frame. Frames and covers shall be designed to accept H20 loads, have a diamond surface finish, and frame height of 6 to 9-inches. Covers shall bear either the word "DRAIN" as appropriate in 3-inch-high letters.

2.5 CATCH BASIN FRAMES AND GRATES

A. Frames and grates shall be of cast iron. Single and double frames and grates shall be equal to pattern No. LF 248-2 and LV2448-2, respectively, four and three flange as manufactured by LeBaron Foundry, Inc. Brockton, Massachusetts, Neenah Foundry Company, Neenah, Wisconsin, Mechanics Iron Foundry Company, Roxbury, Massachusetts, or equal.

B. Catch basin cascade frame and grates shall be Catalog No. LK 120D or LK 121D as manufactured by

LeBaron Foundry Co., or approved equal. Water flowing from left to right requires a Right-Hand Grate. Water flowing from right to left requires a Left-Hand Grate.

2.6 CATCH BASIN HOODS

A. All catch basins shall have hoods installed over the outlet pipe. Hoods shall be cast iron removable or hinged traps that fit over the catch basin outlet pipe. Traps shall be approximately 15-inches wide by 15-inches high and extend 8 to 10-inches from the wall of the structure. Traps shall be Neenah R-3701, Catalog No. L202 as manufactured by LeBaron Foundry Co. or approved equal.

2.7 AREA DRAIN

A. Area drains required for this contract shall be manufactured from PVC pipe stock, utilizing a thermo-molding process to reform the pipe stock to the specified configuration. The drainage pipe connection stubs shall be manufactured from PVC pipe stock and formed to provide a watertight connection with the specified pipe system. This joint tightness shall conform to ASTM D3212 for joints for drain and sewer plastic pipe using flexible elastomeric seals. The pipe bell spigot shall be joined to the main body of the area drain. A PVC cap shall be installed at the bottom of the area drain sump. The pipe stock used to manufacture the main body and pipe stubs of the surface drainage inlets shall meet the mechanical property requirements for fabricated fittings as described by ASTM D3034, Standard for Sewer PVC Pipe and Fittings: ASTM F1336, Standard for PVC Gasketed Sewer Fittings. Area drains shall be manufactured by Nyloplast or approved equal.

B. The grates furnished for area drains in lawn and bioretention areas shall be ductile iron grates and 24" in diameter and be made specifically for each basin so as to provide a round bottom flange that closely matches the diameter of the surface drainage inlet. Grates for area drains in paved areas shall be ductile iron and 12" square. Grates for area drains shall be capable of supporting H-25 wheel loading for in vehicular areas or H-10 loading in pedestrian only areas, unless otherwise noted. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron. Grates shall be provided painted black. Grates in walkways shall meet ADA requirements. Grates in planting beds shall be domed grates. Area drain grates shall be manufactured by Nyloplast or approved equal.

2.8 WATER QUALITY STRUCTURE

A. The water quality drainage structure models indicated on the Contract Drawings are Stormceptor® as manufactured by the Stormceptor Corporation, Rockville, MD. Equivalent structures include Vortechs as manufactured by Vortechnics, Inc. of Portland, ME, and Downstream Defender as manufactured by Hydro International of Portland, ME. Other acceptable equivalent manufactured devices may be used if following requirements are met. Prior to acceptance, the contractor shall receive written approval for use of said substitution from the Town of Concord, MA and/or their authorized representatives.

B. The water quality structure shall have a proven laboratory test record of having the capability to remove a minimum of 80% of the sediment load from the low-flow storm conditions from the total catchment area of the drainage system. Laboratory testing methods shall conform to the "Technology Acceptance Reciprocity Partnership" (TARP) Tier II protocol or other acceptable equivalent method and shall have the capability of removing clay and silt size particles.

C. The available water quality structure laboratory performance documentation shall achieve a grade of "2" or better as rated through the "Massachusetts Stormwater Evaluation Project" (MAStep).

D. The water quality structure shall be installed underground as part of the stormwater system.

E. The water quality structure shall be designed to meet HS-20 loading.

F. The water quality structure shall be vertically oriented with easy access to facilitate maintenance.

G. The water quality structure shall be able to accommodate an “offline” flow configuration in conformance with Massachuesetts DEP regulations effective February 1, 2011. The first 16 inches of oil storage should be lined with fiberglass or other coating acceptable to the Engineer to provide double-wall containment of any hydrocarbon-based material.

H. Water quality structure shall be equipped with high flow bypass that shall be physically separated from the separation area to prevent mixing.

I. The structure shall be maintainable from the surface via access points without requiring entry into the structure.

J. The structure shall be constructed of precast concrete components.

K. The structure shall be designed to prevent the formation of secondary eddy currents or scour conditions.

L. The structure shall be able to be installed to the invert elevations of the drainage system as detailed on the Contract Drawings.

M. The cover for the interceptor shall clearly indicate that it is an oil and sediment interceptor.

N. The water quality structure shall be capable of containing floatable substances such as oil and gasoline within the structure during normal operation as well as periods of service and repair. Floatables containment shall be achieved without the use of floatable additives.

O. The water quality structure shall not be compromised by backwater conditions i.e., trapped pollutants should not be resuspended and scoured from the interceptor during backwater conditions.

P. Calculations stamped by a Professional Engineer shall be supplied to demonstrate that the water quality structures will accept the design flow rates without causing a backwater condition.

2.9 DUCTILE IRON PIPE AND FITTINGS

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

1. Ductile iron pipe shall be that of a manufacturer who can demonstrate at least five years of successful experience in manufacturing ductile iron pipe. The pipe shall be equipped with push-on type, restrained joint, or mechanical joints, as required.

2. All ductile iron drain pipe shall conform to American Water Works Association (AWWA) C150 and AWWA C151.

3. The ductile iron pipe shall be Class 52 and furnished in minimum nominal 18-foot lengths, with Push-on or Mechanical Joints as manufactured by U.S. Pipe and Foundry Company, Atlantic States Cast Iron Pipe Co., Clow Corporation, or approved equal with gaskets conforming to AWWA C111 "Rubber Gasket Joints".

4. Ductile iron drain pipe shall be asphalt seal coated its exterior and interior surfaces in accordance with AWWA C104. The pipe shall be furnished along with necessary materials and equipment recommended by the manufacturer for use in joining pipe lengths and fittings.

5. Fittings shall be short body ductile iron Class 350 Mechanical Joint, conforming to ANSI Specification AWWA C153, latest edition, for pipe sizes 16-inches and smaller, and Class 350 standard Mechanical Joint fittings conforming to AWWA C110, latest edition, for pipe sizes 16 through 24-inches, unless specifically stated otherwise in the Specifications or on the Contract Drawings. Fittings shall have the same lining and coating as the pipe specified above. All fittings shall be marked with the weight and shall have distinctly cast upon them the pressure rating, the manufacturer's identification, nominal diameter of openings and the number of degrees or fraction of the circle on all bends. Fittings greater than 24-inches shall be as specified above except they shall be Class 250.

6. Contractor shall provide all adapters and fittings such as transition couplings, as determined in the field, necessary to complete all cross-connections, whether or not specifically stated in the Contract Drawings and Specifications.

7. All pipe shall be marked with the class, thickness designation and initials of the manufacturer.

8. If required the manufacturer shall supply the Engineer with certificates of compliance with these Specifications and certification that each piece of ductile iron pipe has been tested at the foundry with the Ball Impression Test, Ring Bending, or equal.

9. Pipe for use with split couplings shall be as specified except that the ends shall not have bells or beads but shall have cast or machined shoulders or grooves as necessary for the couplings to be used and shall conform to the specifications of the manufacturer of the couplings. If split couplings are used with grooved ductile-iron pipe, the minimum pipe wall thickness shall be as follows:

Nominal Pipe Size (In.)	Thickness Class
4-12	53
14-18	54
20	55
24	56

10. Pipe for use with sleeve-type couplings shall be as specified except that the ends shall be plain (without bells or beads). The ends shall be cast or machined at right angles to the axis.

B. COUPLINGS AND ADAPTERS FOR DUCTILE IRON PIPE

1. Sleeve-type couplings for plain-end pipe shall be provided with plain rubber gaskets and steel, tee-head bolts with nuts. Couplings shall be given a shop coat compatible with the same outside coating as the pipe specified above. Couplings shall be Dresser style 38 or 138, furnished preassembled, as manufactured by Dresser Industries, Inc., Smith-Blair, Coupling Systems, Inc., or equal.

2. Couplings or adapters as required for connecting existing pipe to new pipe or new pipe to new pipe shall be furnished as required and designed for compatibility with the pipe and operating pressures encountered. Couplings shall be Dresser Style 162 as manufactured by Dresser Industries Inc., or equal. Flanged adapters shall be Dresser Style 128, or equal. Couplings for ductile iron to cast iron pipe shall be Style 53, and for ductile iron to transite pipe shall be style 153, as manufactured by Dresser Industries, Inc., or as manufactured by Smith-Blair, Coupling Systems, Inc. or equal. Transition couplings shall be style 162 as manufactured by Dresser Industries, Inc. or approved equal. Couplings shall be given a shop and field coat of bituminous material compatible with the same outside coating as the pipe specified above.

3. Split couplings may be used for connecting gray cast iron or ductile iron. If split couplings are used with grooved ductile iron pipe, the minimum pipe wall thickness shall be as specified. Split couplings shall be made of malleable iron and shall be suitable for use with grooved-end or shouldered-end, cast iron pipe. They shall be Victualic couplings made by the Victualic Company of America, Elizabeth, New Jersey; Gruvagrip couplings made by Gustin-Bacon Manufacturing Company, Kansas City, Missouri; Groove couplings made by Eastern Malleable Iron Company, Pittsburgh, Pennsylvania; or equal products.

4. Flexible Couplings: Sleeve-type couplings for plain-end ductile iron pipe shall be provided with plain rubber gaskets and steel, track-head bolts with nuts. Couplings shall be given a shop coat compatible with the same outside coating as the pipe specified above. Couplings shall be furnished pre-assembled by the manufacturer.

5. All couplings shall be furnished with the pipe stop removed.

6. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe. The gaskets shall have metallic tips to provide electrical continuity through the joint.

7. The Contractor shall provide suitable filling rings where the layout of the flanged piping is such as to necessitate their use. In materials, workmanship, facing, and drilling, such rings shall conform to the 125 pound ANSI Standard. Filling rings shall be of suitable length with nonparallel faces and corresponding drilling, if necessary, to endure correct assembly of the adjoining piping or equipment.

8. Couplings for exposed pipe shall be of steel and shall be Dresser Style 38, Smith-Blair Style 411, Baker Allsteel, or equal. The couplings shall be provided with steel bolts and nuts.

9. At the Contractor's option, flexible connections in the piping shall be sleeve-type couplings, split couplings or mechanical joint pipe as herein specified.

C. INSPECTION, TESTS AND ACCEPTANCE FOR DUCTILE IRON PIPE

1. All pipe delivered to the job site shall be accompanied by test reports certifying that the pipe and fittings conform to "AWWA Standard for Ductile Iron Pipe, for Water and Other Liquids" (AWWA H3) and (AWWA C151).

2. All tests shall be made in accordance with the methods prescribed by the above mentioned AWWA Standards, and the acceptance or rejection shall be based on the test results.

3. Pipe which does not conform to the requirements of this contract shall be immediately removed and replaced by the Contractor.

4. All ductile iron pipe to be installed under this Contract may be inspected at the foundry for compliance with these Specifications by an independent testing laboratory selected by the Owner. The Contractor shall require the manufacturer's cooperation in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of the inspection of a reasonable amount of disapproved pipe, will be borne by the Owner.

D. FLANGED JOINTS FOR DUCTILE IRON PIPE

1. For flanged joints, gaskets shall be ring gaskets of rubber with cloth insertion. Gaskets twelve (12)-inches in diameter and smaller shall be 1/16-inch thick, gaskets larger than twelve (12)-inch shall be 3/32-inch thick.

2. Flanged joints shall be made with bolts, bolt studs with a nut on each end, or studs with nuts

where the flange is tapped. The number and size of bolts shall conform to the same ANSI Standard as the flanges. Bolts and nuts shall, except as otherwise specified or noted on the Contract Drawings, be Grade B conforming to the ASTM Standard Specification for Carbon Steel, Externally and Internally Threaded Standard Fasteners, Designation A307. Bolts and studs shall be of the same quality as machine bolts. Flanged ductile iron pipe from 3 to 48-inches in diameter shall be classified by Underwriters Laboratories Inc. in accordance with AWWA C115.

2.10 PVC PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

B. PVC (Polyvinyl Chloride) Gravity Sewer Pipe: ASTM D3034, SDR 35, for elastomeric gasket joints. Pipe 18 to 27 inches in diameter shall conform to ASTM F679, T-1 heavy wall.

a. Fittings: Elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477.

2.11 CORRUGATED POLYETHYLENE PIPE

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

1. Corrugated polyethylene pipe shall have an interior surface that is smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. Pipe shall conform to AASHTO M-294, AASHTO M252, or AASHTO MP6, Type S depending on the diameter of the pipe required.
2. Pipe and fittings shall be high-density polyethylene meeting the requirements of ASTM D3350.
3. Pipe units shall have a minimum laying length of 20-feet except as otherwise indicated or allowed by the Engineer.
4. Pipe shall be installed with a minimum 12-inch cover for AASHTO H-20 loading.

B. Corrugated Polyethylene Flared End Section:

1. The pipe shall have an interior surface that is smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. Flared end section shall conform to AASHTO M-294.

C. Joints on Corrugated Polyethylene Pipe.

1. The pipe and fitting joints shall be bell-and spigot with watertight gaskets.
2. Pipe entrances at catch basins shall be made with a mortar made with Type II cement. Mortar mixture shall follow instructions provided by cement manufacturer. Pipe connections at drain manholes and water quality structures shall be made with integral flexible rubber sleeves and Corrugated Pipe Adapters designed for use with the pipe and sleeves.

2.12 REINFORCED CONCRETE PIPE (Class IV; 12 through 48-inches)

A. General: Provide pipes of the following materials of class indicated. Provide pipe fittings and accessories of same materials and class as pipes with joining method, as indicated. The piping shall be manufactured by an established manufacturer of good reputation in the industry and in a permanent plant adapted to meet all the design requirements of the pipe.

1. The pipe shall have an interior surface, which is smooth and even, free from roughness, projections, indentations, offsets, or irregularities of any kind. Pipe shall conform to ASTM "Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe," Designation: C76 and shall be wall B for the class IV and with additions and exceptions as follows:

2. Type II cement shall be used unless otherwise approved by the Engineer. Admixtures shall not be used except with prior approval of the Engineer.

3. Elliptical reinforcement will not be permitted. Longitudinal reinforcement shall be continuous. Reinforcement shall have a minimum cover of ¾-inch. Pipe shall have no lifting holes.

4. Absorption shall be as specified under "Tests of Materials and Pipe Units."

5. Pipes manufactured by the centrifugal process or in vertical forms shall be cast of wet-mix concrete. Concrete cast in vertical forms shall be consolidated by internal or external mechanical vibration or both. The vibrating equipment shall be operated at high speed (more than 5,000 rpm) and have a low amplitude. Pipes manufactured by the modified packer process shall have a supplementary concrete densification operation that shall assure the attainment of full bond between reinforcement and concrete and also eliminate any displacement of the reinforcement. Additional passes with the revolving packerhead or the use of additional vibrators attached to the platform or exterior forms will not be acceptable.

6. Pipe units shall have a minimum laying length of 8-feet except as otherwise indicated or allowed by the Engineer.

7. Pipe may be rejected for any of the following reasons:

   a. Exposure of any wires, positioning spacers or chairs used to hold the reinforcement cage in position, or steel reinforcement in any surface of the pipe, except as permitted by Section 8.2 of ASTM C76.

   b. Transverse reinforcing steel found to be in excess of 1/4-inch out of specified position after the pipe is molded.

   c. Any shattering or flaking of concrete as a crack.

   d. Voids, with the exception of a few minor bugholes, on the interior and exterior surfaces of the pipe exceeding 1/4-inch in depth unless properly and soundly pointed with mortar or other approved material.

   e. A hollow spot (identified by tapping the internal surface of the pipe) which is greater than 30-inches in length or wider than 3 times the specified wall thickness.

   f. Defects that indicate imperfect molding of concrete; or any surface defect indicating honeycomb or open texture (rock pockets) greater in size than area equal to a square with a side dimension of 2½ times the wall thickness or deeper than two times the maximum graded aggregate size; or local deficiency of cement resulting in loosely bonded concrete.

   g. Any of the following:

(1) A crack having a width of 0.005 to 0.01-inches throughout a continuous length of 36-inches or more.

(2) A crack having a width of 0.0 to 0.03-inches or more throughout a continuous length of 1-foot or more.

(3) Any crack greater than 0.005-inches extending through the wall of the pipe and having a length in excess of the wall thickness.

(4) Any crack showing two visible lines of separation for a continuous length 2-feet or more, or an interrupted length of 3-feet or more anywhere in evidence, both inside and outside.

(5) Cracks anywhere greater than 0.03-inches in width.

h. Application of any wash coat of cement or grout to the pipe will not be permitted without approval of the Engineer. Any pipe dressing procedures shall be subject to the approval of the Engineer.

B. Joints on Reinforced Concrete Pipe:

1. Pipe joints for all reinforced concrete pipe shall be of the rubber gasket type in which the gaskets are in compression and which will permit both longitudinal and angular movement. Each unit of pipe shall be provided with proper ends made of concrete formed true to size and formed on machined rings to ensure accurate joint surfaces.

2. Joints and gaskets for pipe shall be the O-ring gasket type and shall conform to the requirements of ASTM C443 and the additional requirements specified.

3. Joints shall be of such design that when tested under an average internal hydrostatic pressure of 13 pounds per square inch for a period of 10 minutes, no visible leakage will result. The diameters of the joint surfaces which compress the gasket shall not vary from the true diameters by more than 1/16-in or the amount permitted by the appropriate above-mentioned ASTM Standard Specifications, whichever is less.

4. Gaskets shall be of a composition and texture which is resistant to common ingredients of sewage, industrial wastes, and groundwater, and which will endure permanently under the conditions likely to be imposed by this service. Gaskets shall be the product of a manufacturer regularly engaged in the manufacture of rubber gaskets for pipe joints.

C. Flared End Sections: Reinforced Concrete Pipe flared end sections shall conform to requirements of AASHTO M170, minimum Class IV.

2.13 SUBSURFACE INFILTRATION CHAMBERS

A. Subsurface detention chambers shall be HDPE chamber system as manufactured by StormTech, Cultec, or similar. The chambers will be handled, stored, and installed according to manufacturer's specifications and details. The chambers will be placed on a drainage course bed with a minimum of depth of six inches. The chambers shall not be placed with backfill depths greater than 96" to surface as per manufacturer's details.

B. The galley shall have both of its ends open to allow for unimpeded hydraulic flows and for visual inspection and maintenance of the row's entire length. The galley shall have a circular, indented, flat surface on the top for an inspection port or clean-out.

C. The galley shall be analyzed and designed using AASHTO methods for thermoplastic culverts contained in the LRFD Bridge Design Specifications, 2nd Edition, including Interim Specifications through 2001. Design live load shall be the AASHTO HS20 vehicle. Design shall consider earth and live loads as appropriate for the specified depth of fill.

D. The end cap shall be designed to fit into any corrugation of a galley, which allows capping a galley that has its length trimmed and segmenting rows into storage basins of various lengths.

E. The end cap shall have saw guides to allow easy cutting for various diameters of pipe that may be used to inlet the system. The end cap shall have excess structural adequacies to allow cutting an orifice of the required size at any invert elevation.

F. The primary face of an end cap shall be curved outward to resist horizontal loads generated near the edges of beds.

2.14 CLEANOUTS

A. General: Provide cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.

2.15 IDENTIFICATION

A. Detectable Underground Warning Tapes: Acid and alkali-resistant polyethylene plastic film warning tape, 6-inches wide by 4-mils minimum thickness, with continuously printed caption in black letters "CAUTION - xxxxx LINE BURIED BELOW." The text and color of the tape shall be as shown in the table below. The tape shall have a metallic core encased in a protective jacket for corrosion protection and be detectable by a metal detector when the tape is buried up to 2.5-feet deep.

Color	Utility
Safety Red	Electric
High Visibility Safety Yellow	Gas, Oil, Steam
Safety Alert Orange	Telephone, Communications, Cable Television
Safety Precaution Blue	Water System, Irrigation
Safety Green	Sanitary Sewer, Storm Sewer
White	Proposed Excavation

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

A. General: General Locations and Arrangements: Contract Drawings indicate the general location and arrangement of the underground storm drainage system piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. Any modifications to the layout of the storm drainage system shall be submitted to the Engineer for review and approval at least five days prior to the start of the affected work.

B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations, accepted practices, and utility owner’s requirements. Maintain swab or drag in line and pull past each joint as it is completed. All pipe shall be laid in the dry.

C. When bell and spigot pipes are used, bell holes shall be dug in the bedding to accommodate the bells. They shall be deep enough to ensure that the bell does not bear on the bottom of the hole but shall be excessively wide in the longitudinal direction of the installation.

D. Use manholes for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into an existing storm drain is indicated.

E. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited without the written approval of the Engineer.

F. Install piping pitched down in direction of flow as indicated on the Contract Drawings.

G. Extend storm drainage system piping to connect to building roof drains, of sizes and in locations indicated on the Contract Drawings.

H. Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

I. Acceptance of Pipe: Acceptance will be on the basis of tests specified herein before. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor.

J. Pipe Storage: Pipe sections shall not be stored on areas over the newly laid pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.

K. Handling Pipe: Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.

L. Laying Pipe: Except where a concrete cradle or envelope is required, the pipe shall be laid in a crushed stone cradle. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

M. Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned.

N. Alignment and Placement: All pipe shall be laid with extreme care as to grade and alignment. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.

2. The Contractor shall establish centerline and offset stakes at each manhole, plus one intermediate centerline and offset stake as a check point between manholes. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.

O. Cleaning: Care shall be taken to prevent earth, water and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the

pipeline and manholes being careful to prevent soil, water and debris from entering any existing Drain.

1. Place plugs in end of uncompleted conduit at end of day or whenever work stops.

2. Flush lines between manholes if required to remove collected debris.

P. Review of Completed Storm Drain System: The completed drain system shall be visually inspected by the Owner's Representative. If the visual observation of the completed drain or any part thereof shows any pipe, manhole, or joint to be of defective work or material, the defect shall be replaced or repaired as directed by the Engineer or the Owner's Representative. The Contractor shall coordinate and provide site access for inspection.

3.2 PLACEMENT OF DUCTILE IRON PIPE AND FITTINGS

A. Care shall be taken in loading, transportation, and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe and fittings shall be examined before placement, and no piece shall be installed which is found to be defective. Any damage to the pipe coatings shall be repaired as directed by the Engineer.

B. If any defective pipe is discovered after it has been placed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense. All pipe and fittings shall be kept clean until they are used in the work, be thoroughly cleaned before placement, and when placed, shall conform to the lines and grades required. Ductile iron pipe and fittings shall be installed in accordance with requirements of AWWA Standard Specification C600 except as otherwise provided herein. A firm even bearing throughout the length of the pipe shall be constructed by compacting gravel borrow around the pipe and up to the springline.

1. Blocking will not be permitted.

C. All pipes shall be sound and clean before placement. When pipe laying is not in progress, including lunchtime, the open ends of the pipe shall be temporarily closed by watertight plug or other acceptable means. Alignment shall be maintained during placement. The deflection at joints shall not exceed sixty percent of that recommended by the manufacturer. Fittings, in addition to those shown on the plans, shall be provided, if required, in crossing utilities, which may be encountered upon opening the trench. Solid sleeves shall be used only where allowed by the Engineer.

D. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a push-on type bell shall be beveled to conform to the manufactured spigot end. Cement lining shall be inspected for damage and shall be remortared as required to ensure a continuous lining.

E. Concrete thrust blocks shall be installed at all fittings valves and hydrants and other locations as indicated on the Contract Drawings and as directed by the Engineer. Minimum bearing area shall be as shown on the Contract Drawings. Thrust blocks shall bear against undisturbed material, and shall be provided with wooden side forms. In the event that the use of thrust blocks is not practical, the Contractor shall provide an alternate method of joint restraint, at no additional cost, as directed by the Engineer.

F. The Contractor shall take care not to damage pipe by impact, bending, compression, or abrasion during handling, and installation. Joint ends of pipe especially shall be kept clean.

G. Pipe shall be stored above ground at a height no greater than 5 feet and with even support for the pipe barrel.

H. Only nylon-protected slings shall be used for handling the pipe. No hooks, chains or bare cables will be permitted.

I. Gaskets shall be shipped in cartons and stored in a clean area, away from grease, oil, heat, direct sunlight and ozone producing electric motors.

J. Jointing of ductile iron push-on pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The last 8-inches of the outside of the spigot end of pipe and the inside of the bell end of pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be painted with a lubricant just prior to making up the joint. The spigot end shall then be gently pushed home into the bell. The position of the gasket shall be checked to ensure that the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

1. Jointing Ductile Iron Pipe (Push-On Type): Push-on joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe, and the joint surfaces cleaned and lubricated. The plain end of the pipe to be entered shall then be inserted in alignment with the bell of the pipe to which it is to be joined, and pushed home with a jack or by other means. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is correctly located.

2. Jointing Mechanical Joint Fittings: Mechanical joints at valves, fittings, and where designated shall be installed in accordance with the "Notes on Method of Installation" under ANSI Specification A 21.11 and the instructions of the manufacturer. To assemble the joints in the field, the Contractor shall thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torque. Under no condition shall extension wrenches or pipes over handles or ordinary ratchet wrenches be used to secure greater leverage.

K. Installation and jointing of ductile iron pipe shall be in accordance with AWWA C600, Sections 9b and 9c, latest revision, as applicable.

L. Ductile iron pipe installed within 5-feet of gas lines shall be fully encased with polyethylene material. Polyethylene shall be 8-millimeters thick and comply with AWWA C-105.

3.3 PVC PIPE

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. PIPE HANDLING

1. All pipe and fittings shall be carefully handled from the truck onto the ground and into the trench or excavation so as to prevent damage to the pipe. Pipes shall be kept free of dirt and foreign material especially on the inside. Joint ends of pipe shall especially be kept clean.

2. Pipe stored on site shall be protected from heat and direct sun light and shall be suitably ventilated.

3. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before laying, and no piece shall be installed which is found to be defective.

C. ALIGNMENT AND PLACEMENT OF PVC PIPE

1. Bedding material for the pipe must be installed with care in the area around the pipe. Bedding material must be placed to provide uniform and adequate support under pipe. Do not use blocking to bring pipe up to grade.

2. Provide bell holes at each joint to permit joint to be assembled properly while maintaining uniform pipe support.

3. Place and consolidate the bedding material under the pipe haunch to provide adequate side support while avoiding both vertical and lateral displacement of pipe.

4. Initial backfill must be completed to a point at least 12-inches over the top of the pipe and be hand placed. Use little or no tamping of initial backfill directly over the top of pipe. Compaction methods may be utilized during final backfilling.

5. Jointing of PVC sewer and water pipe and fittings shall be done in accordance with the printed recommendations of the manufacturer and as specified. The bell end of the pipe shall be thoroughly cleaned. The joint surfaces and the gasket shall be lubricated prior to making up the joint. The position of the gasket shall be checked to ensure the joint has been properly made and is watertight. Care shall be taken not to exceed the manufacturer's recommended maximum deflection allowed for each joint.

6. When jointing PVC conduit pipe, it shall be cut square, conduit ends cleaned, an even coating of solvent cement applied to the pipe end and socket, and the conduit firmly pushed together until the conduit bottoms in the socket. The conduit shall be rotated 1/4 turn immediately after bottoming in the socket to ensure even spread of the cement.

7. Detectable warning tape shall also be installed 2-feet below the existing ground surfaces for later use in locating the pipe's exact position.

3.4 INSTALLATION OF REINFORCED CONCRETE PIPE AND PIPE FITTINGS

A. General: Install piping in accordance with ASTM D2321, the governing authorities having jurisdiction of the utility , and the manufacturer’s instructions, except where more stringent requirements are required by the Contract Documents.

B. Acceptance of Pipe: Acceptance will be on the basis of tests specified hereinbefore. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor at no cost to the Owner.

C. Pipe Storage: Pipe sections shall not be stored on areas over the newly laid pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.

D. Laying Pipe: Except where a concrete cradle or envelope is required, the pipe shall be laid in a crushed stone cradle. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

E. Jointing Pipe: After the pipes are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned.

F. Alignment and Placement: All pipes shall be laid with extreme care as to grade and alignment. Each pipe shall be so laid as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.

2. The Contractor shall establish centerline and offset stakes at each manhole, plus intermediate centerline and offset stakes as needed to ensure proper alignment and grade. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.

G. Cleaning: Care shall be taken to prevent earth, water and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water, and debris from entering any existing Drain.

1. Place plugs in end of uncompleted conduit at end of day, or whenever work stops.

2. Flush lines between manholes to remove collected debris.

H. Review of Completed Reinforced Concrete Pipe System: If the visual observation of the completed drain or any part thereof shows any pipe, manhole, or joint to be of defective work or material the defect shall be replaced or repaired as directed at no cost to the Owner. The visual observation shall be conducted by the Engineer and any defects shall be as identified by such. The Contractor shall coordinate and provide site access for the Owner.

3.5 INSTALLATION OF CORRUGATED POLYETHYLENE PIPE AND PIPE FITTINGS

A. General: Install piping in accordance with governing authorities having jurisdiction, except where more stringent requirements are indicated.

B. Acceptance of Pipe: Acceptance will be on the basis of tests specified hereinbefore. The quality of all materials used in the pipe, the process of manufacture, and the finished pipe shall be subject to review by the Engineer. Inspection may be made at the place of manufacture, or on the work site after delivery or at both places and the pipe shall be subject to rejection at any time on account of failure to meet any of the specification requirements, even though sample pipe units may have been accepted as satisfactory at the place of manufacture. All pipe which is rejected shall be immediately removed from the project site by the Contractor.

C. Pipe Storage: Pipe sections shall not be stored on areas over the newly placed pipe or other pipelines which might be damaged by the superimposed load, and storage sections shall be restricted to approved areas.

D. Handling Pipe: Each pipe unit shall be handled into its position in the trench only in such manner and by such means, as the Engineer accepts as satisfactory. The Contractor will be required to furnish suitable devices to permit satisfactory support of all parts of the pipe unit when it is lifted.

E. Placing Pipe: Except where a concrete cradle or envelope is required, the pipe shall be placed in a crushed stone cradle. In trenches, no blocking or supporting of the piping by concrete, stones, bricks, wooden wedges, or method other than bedding the pipe on crushed stone will be permitted. Each length of pipe shall be shoved home against the pipe previously laid and held securely in position. Joints shall not be "pulled" or "cramped" without approval of the Engineer.

F. Jointing Pipe: After the pipe are aligned in the trench and are ready to be jointed, all joint surfaces shall be cleaned.

G. Alignment and Placement: All pipe shall be placed with extreme care as to grade and alignment. Each pipe shall be so placed as to form a close joint with the next adjoining pipe and bring the inverts continuously to the required grade.

1. Stakeout of drain work and setting of line and grade is the responsibility of the Contractor.

2. The Contractor shall establish centerline and offset stakes at each manhole, plus intermediate centerline and offset stake as needed to ensure proper alignment and grade between manholes. Laser aligning shall not be used to establish a continuous line in excess of 400-feet.

H. Cleaning: Care shall be taken to prevent earth, water, and other materials from entering the pipeline. As soon as possible after the pipe and manholes are completed, the Contractor shall clean out the pipeline and manholes being careful to prevent soil, water, and debris from entering any existing Drain.

1. Place plugs in end of uncompleted conduit at end of day or whenever work stops.

2. Flush lines between manholes to remove collected debris.

Review of Completed Corrugated Polyethylene Pipe System: If the visual observation of the completed drain or any part thereof shows any pipe, manhole, or joint to be of defective work or material the defect shall be replaced or repaired as directed. The visual observation shall be conducted by the Engineer and any defects shall be as identified by such. The Contractor shall coordinate and provide site access for the Owner.

3.6 INSTALLATION OF DRAIN MANHOLES AND CATCH BASINS

A. The bases shall be supported on a compacted level foundation of gravel borrow at least 12-inches thick.

1. Manhole risers and tops shall be installed using approved butyl-rubber polymer type gasket for sealing joints of manhole risers and tops; jointing shall be performed in accordance with the manufacturer's recommendations. Manhole risers and tops shall be installed level and plumb. Water shall not be permitted to rise over newly made joints, nor until after inspection as to their acceptability. All jointing shall be done in a manner to ensure watertight joints. Openings shall be provided in the precast concrete manhole risers to receive entering pipes and these openings shall be made at the place of manufacture. Connection of pipes to manholes shall be by means of a cement mortar joint.

2. Care shall be taken to ensure that the openings are made to permit setting of the entering pipe at its correct elevation as indicated or directed. Manhole risers and tops shall be installed so that the manhole steps shall be in alignment.

3. All holes used for handling shall be thoroughly plugged with non-shrink grout.

4. Subsequent cutting or tampering in the field, for purpose of creating new openings or altering existing openings, will not be permitted except at the discretion of the Engineer or if necessary concrete block manhole(s) shall be used.

5. Clean all debris, mortar, and soil from the bottom of all structures prior to final acceptance of the project.

3.7 SETTING MANHOLE FRAMES AND COVERS AND CATCH BASIN FRAMES AND GRATINGS

A. Manhole frames shall be set with tops conforming accurately to the grade of the pavement or finished ground surface or as indicated on the Contract Drawings or as directed. Frames shall be set concentric with the top of the manhole on a minimum of two courses of brick and in a full bed of mortar so that the space between the top of the brick and mortar and the bottom flange of the frame shall be completely filled and made watertight. A thick ring of mortar extending to the outer edge of

the concrete shall be placed all around the bottom flange. The mortar shall be smoothly finished to a height of 5-inches above the flange.

1. Only clean bricks shall be used in brick work to adjust frame elevations. The brick shall be moistened by suitable means.

2. Manhole covers shall be left in place in the frame until completion of other work at the manholes.

3. Frame castings for catch basins shall be set on a minimum of two courses of brick and in full mortar beds true to line and grade. Frames shall be set in a grout bed and the cement mortar shall be brought up to a height of not less than 5-inches above the bottom of the frames. Where directed, the castings shall be temporarily set at such grades as to provide drainage during construction. The castings of structures located within the pavement area shall not be completely set to the established grade until the bottom course of pavement has been laid. The final setting of all other casting shall be performed at the proper stage of construction as directed.

3.8 CHANGE IN TYPE

A. When an existing catch basin is to be converted to a manhole, the frame and grate shall be carefully removed and a new frame and cover installed to finish grade. If in the opinion of the Engineer the existing casting is reusable, it may be reused in the work, otherwise, it shall be disposed of off-site.

1. The sump of the catch basin shall be thoroughly cleaned of debris and silt and the interior surfaces brushed to remove contaminants.

2. The sump shall be thoroughly filled with compacted gravel to a level no greater than 6 inches below the pipe invert. A cast-in-place concrete invert shelf and channel shall be poured and shaped to the lower half of the pipes.

3. New openings in existing structures shall be carefully cut with power saws of the proper size and elevation to accept the new connection. Damage to the structure caused by the Contractor's construction methods shall be repaired at no additional cost.

3.9 STRUCTURE REBUILT

A. When in the opinion of the Engineer existing masonry structure walls show deterioration, the structure shall be rebuilt. The casting and deteriorated masonry shall be removed in a careful and neat manner until only a sound condition remains. Concrete blocks shall be used to rebuild the structure. The new masonry construction, replacing of the casting, and other incidental work shall be performed as specified above.

1. The Contractor's base bid shall include rebuilding [ ] vertical linear feet of existing manhole or catch basin structures.

3.10 INSTALLATION OF TANKS

A. If precast tank sections are to be field assembled, adequate waterproofing shall be used at the joint to resist the waterhead at that joint.

B. Structure shall be supported on a compacted level foundation of gravel borrow a minimum of 12 inches thick.

3.11 FIELD TESTING OF CORRUGATED POLYETHYLENE PIPING:

1. The pipe shall be cleaned and visually inspected for offsets and obstructions prior to testing.

2. The total length of each pipe installed on the project shall be tested or inspected for deflection. Conveyance pipes connecting at both ends to concrete drainage structures (catch basins, manholes, outlet control structures, water quality structures, etc.) shall be mandrel tested. Deflection of pipes used for stormwater detention/retention/infiltration systems, and pipes connecting to wye connections, building connections, trench drains, and other connections that do not allow mandrel testing shall be verified by visual inspection by the Owner's Representative during installation.

3. Mandrel tests shall be performed by the Contractor and observed by the Owner's Representative not sooner than 20 days after completion of installation and compaction of backfill. Testing for pipes greater than 24-inch in diameter shall be tested prior to the installation of drainage structure cone and frame.

4. Installed pipe shall be tested to ensure that the maximum deflection of the pipe does not exceed 7.5 percent of its base inside diameter. The base inside diameter is defined as the specified nominal diameter minus the allowable inside diameter tolerance of 1.5% but not more than 1/2 inch.

5. A mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. The mandrel diameter shall be verified and approved by the Owner's Representative prior to use. Use of an unapproved mandrel will invalidate the test. If the mandrel fails to pass through the pipe, the pipe will be deemed to be over-deflected.

6. The mandrel shall be a rigid device, with an odd number of legs (9 legs minimum) having an effective length not less than its nominal diameter. The mandrel shall be fabricated of steel with pulling rings at each end.

7. The minimum diameters at any point along the full length are as follows:

Nominal Size	Minimum Mandrel Diameter
6"	5.3"
8"	7.0"
10"	8.8"
12"	10.6"
15"	13.2"
18"	15.8"
24"	21.1"
30"	26.4"
36"	31.7"
42"	37.0"
48"	42.2"
54"	47.5"
60"	52.8"

3.12 AREA DRAINS

A. Install area drains per manufacturer specifications.

3.13 SUBSURFACE INFILTRATION CHAMBERS

A. Install chambers, bedding, and inspection ports per manufacturer specifications.

3.14 CLEANOUTS

A. Install cleanouts and extensions from sewer pipe to grade as indicated on the Contract Drawings. Set cleanout frame and cover in concrete 12 by 12 by 6-inches deep, except where location is in bituminous or concrete paving. Set top of cleanout 1-inch above surrounding earth grade or flush with grade when installed in paving.

3.15 BACKFILLING

A. General: Conduct backfill operations of open-cut trenches closely following laying, jointing, and bedding of pipe, and after initial inspection and testing are completed, all in accordance with local requirements and the contract documents.

B. Initial backfill shall be placed evenly on both sides of the pipe to distribute the load and not to cause movement or deflection of the pipe.

3.16 FINAL INSPECTION

A. Final inspection and acceptance of pipe, valves, appurtances, hydrants and precast concrete structures shall be made by the Owner's Representative and the utility owner having jurisdiction of the particular system. Prior to placing the systems in service all components shall be inspected, with the Owner's Representative present, to ensure that no debris or other contaminants are present. If necessary, the Contractor shall clean the structures and flush piping.

B. The Contractor is responsible for coordinating and scheduling the inspection of the work by local jurisdictional authorities. No additional payment will be made for inspections and permits required in the performance of the work.

END OF SECTION 33 40 00

SECTION 33 4620

LANDSCAPE DRAINAGE

PART 1 – GENERAL

1.01 GENERAL REQUIREMENTS

A Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.02 DESCRIPTION OF WORK

A Work Included: Execute landscape drainage complete, as shown on the Drawings, and as specified herein.

1.03 RELATED WORK

A The following Related Work to be performed under the designated Sections:

1 Earthwork - Section 31 2000
2 Site Concrete - Section 32 1313
3 Miscellaneous Site Improvements - Section 32 3000
4 Planting - Section 32 9000
5 Soil Preparation - Section 32 9113
6 Metals
7 Storm Drainage

1.04 SUBMITTALS

A Product Data: Manufacturers' current catalog cuts and specifications and/or test results demonstrating compatibility with the specifications for the following:

1 Piping - solid, corrugated, perforated.
2 Trench Drain and components.

B Submit certificates, copies of independent test reports, or research reports showing compliance with specified performance requirements.

C Landscape Drainage Systems Testing:

1 Inspection of Existing conditions.

a) Notification: Submit written notification of all discrepancies in the Drawings or Existing conditions which preclude successful installation of landscape drainage work as specified.

2 Testing Results for Obstructions and Debris of the Installed Landscape Drainage System.

a Before trench backfilling and final connections are completed to the drainage lines installed in Section 33 41 00 Storm Drainage, test with

adequate flowing water and where possible visual observation to confirm that there is no debris or obstructions, bad connections or any other fault in Landscape Drainage System's drains.

b Written Drainage Testing Certification

a) The Contractor shall provide written certification that drainage flows unobstructed form each cleanout, tree pit, shrub bed, pavement drain and yard drain.

b) Any part of the Landscape Drainage system which fails this testing for any reason shall have the problem corrected by the Contractor and that portion retested until it passes at no additional expense to the Owner.

1.05 PROJECT/SITE CONDITIONS

A Protection of Utilities:

1 Provide temporary support and protection of underground and surface utility structures, drains, services and other improvements to remain.

2 Where grade or alignment of pipe is obstructed by existing utility structures such as conduits, ducts or pipes, notify the Landscape Architect in writing and provide a recommendation to reroute the underdrain line meeting all other drawing and specification requirements for his approval.

3 Restore all damaged improvements to original condition at no additional cost.

1.06 DELIVERY, STORAGE, AND HANDLING

A Delivery: All containerized products shall be delivered to the site in manufacturer's original, unopened, legibly labeled containers. All pipe to be delivered bound securely to prevent damage. Supply pallets as required to protect products.

B Storage: Protect materials from damage, water and rust. Store pipes on beds that are full length of pipe. (Protect plastic materials from direct sunlight.)

C Pipe: Cap openings to prevent entry of dust, debris and other foreign matter.

1.07 SEQUENCING AND SCHEDULING

A Concealed Work: Prior to and work in this Section Verify in the field the locations and invert elevations of all drainage structures to receive landscape subdrainage connections.

1 Refer to Civil Engineering Drawings for storm drainage structures.

B Lines and Levels: Establish for each drainage system and coordinate with other systems to prevent conflicts and maintain proper clearances.

1.08 DEFINITIONS

A References to Landscape Architect shall mean Architect or the Architect's designated representative.

PART 2 – PRODUCTS

2.01 TRENCH DRAIN MANUFACTURED UNITS

A Trench Drain (Straight and Curved Trench Drain)– Type A: KlassikDrain – KS100S polymer concrete with galvanized edge rail, Manufactured by Aco Polymer Products, 440-285-7000.

1 Channel: K010 Neutral channel @ 7.83” depth. Refer to the drawings.

2 Catch Basins: K900 in line catch basin

3 Trash Bucket: Series 900.

4 Closing End Caps and Outlet Caps: KS010.

5 PVC Adaptors: System KS010.

6 Sealant: Aco Seal sealant for polymer concrete and fiberglass trench drain.

7 Grate: KlassikDrain Grate ADA Iron, Type 478Q-ductile iron, Black, Medium Industrial.

2.02 RIGID PIPE: Solid And Perforated PVC Drain Pipe And Fittings

A PVC drain and fittings shall conform to ASTM D-30343 or ASTM F679 (SDR 35 minimum). Polymer compounding and classification shall be in accordance with ASTM D-1784, (Class 12454-B).

B All fittings shall be injected molded. Fabricated fittings are not allowed except as permitted by the Landscape Architect.

C Joint for PVC pipe shall be oil resistant compression ring of elastomeric material conforming to ASTM D-3212, push on bell and spigot pressure type joints.

D Solid PVC pipe and fittings and components shall be by a manufacturer who meets the specifications for these items as specified herein.

E Pipes shall be sized to meet the requirements as shown on the Drawings.

PART 3 – EXECUTION

3.01 EXAMINATION

A Verification of Conditions: Verify exact locations all storm drainage structures and drain lines prior to beginning of work. Identify required layout lines, finish grading, subgrading, contours, and datum. Immediately report to Landscape Architect all discrepancies found prior to installation of Landscape Drainge System.

B Establish the connection outfall locations, grades and depths to accommodate the minimum 1% pitch (unless shown otherwise on the drawings) required for all subdrainage piping.

1 Concealed Work Storm Drainage Structure's: Prior to and work in this Section Verify in the field the locations and invert elevations of all drainage structures to receive landscape subdrainage connections.

2 Verify before any excavation that all subdrainage lines will have a minimum of 1% pitch to the storm drainage structure unless noted on the drawings.

a Notify the Landscape Architect immediately if the minimum 1% pitch is not achievable.

C Refer to the Site Grading Plans and Details, Subdrainage Plans and Details and the Planting Plans and Details for the location and installation of the Site Drainage System and as specified herein.

3.02 INSTALLATION OF TRENCH DRAIN

A Examination

1 Contractor shall verify that the field measurements and recessed dimensions are as shown on the shop drawings prior to releasing materials for fabrication by the manufacturer.

2 Installer shall examine conditions under which work is to be performed and shall notify the contractor in writing of unsatisfactory conditions. Installer shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

B Installation

1 Install the channel and trench drain system in accordance with the governing regulations, the industry standards, and manufacturer's written installation instructions.

2 Work shall be aligned plumb, level, and where required, flush with adjacent surfaces.

3 Channel and trench drain joints shall have sealant applied in accordance with the manufacturer's written installation instructions.

4 Provide positive gradient from the drain via drain pipe to storm sewer connections. Pipe gradient shall be 1% min unless noted otherwise.

C Adjusting, Cleaning and Protection

1 Inspect the system components for a proper fit. Adjust, repair or replace components not conforming to the requirements. Repair or replace components not conforming to the requirements.

2 Protect the finished work from damage during the remainder of the construction period.

3 Finished units shall be without damage. Units damaged during shipping or construction shall be repaired or replaced by the contractor at the expense of the damaging party in accordance with the contract requirements.

4 Protect installation from damage by work of other sections. After installation of frame, install temporary filler of plywood in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and project is near time of Substantial Completion.

5 Install grating near time of Substantial Completion.

END OF SECTION